

**POPULATION – ENVIRONMENT – DEVELOPMENT  
INTERACTIONS**

**Edited by**

**John I Clarke and Léon Tabah**



Vue de HONG-KONG



**1995**

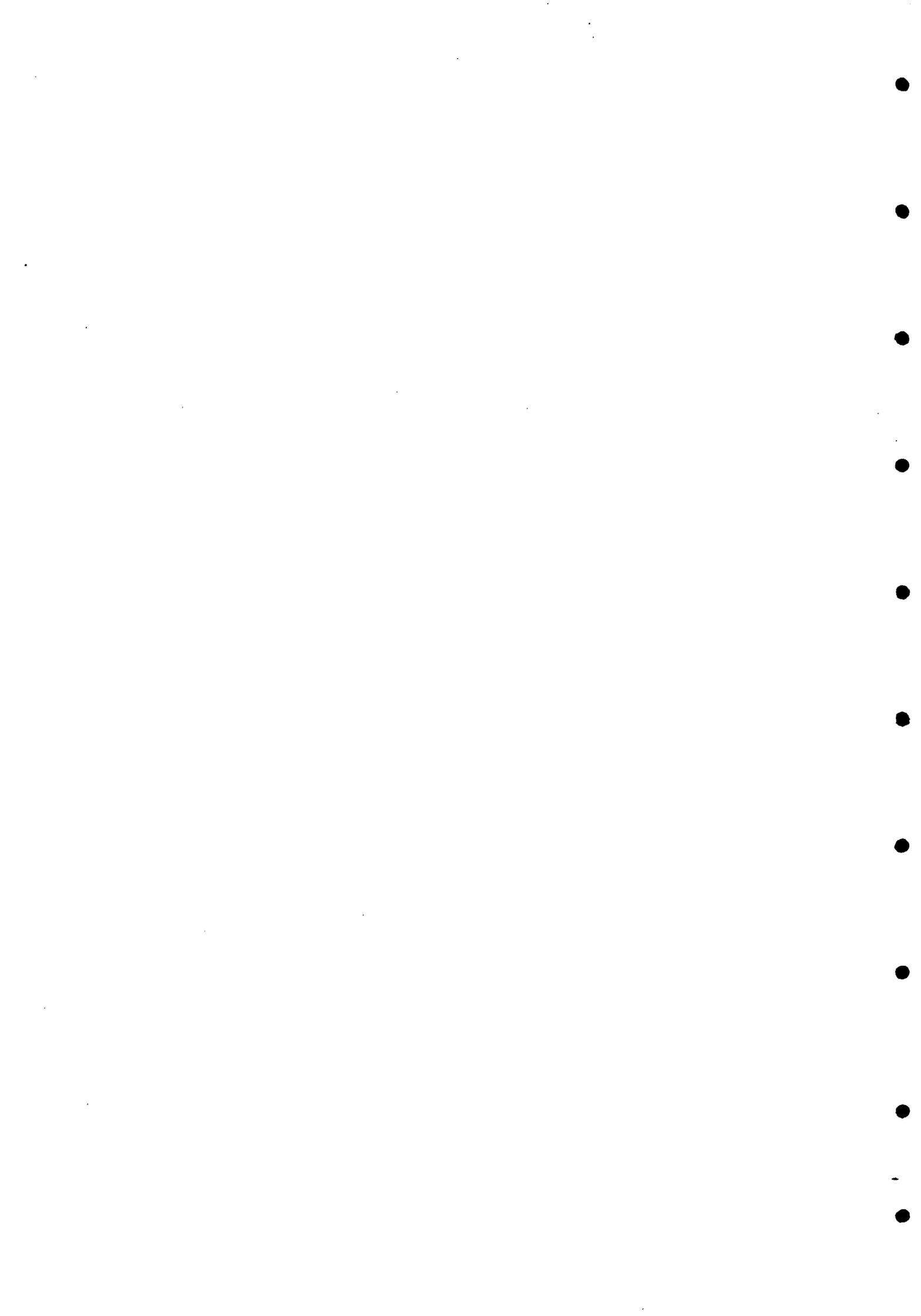
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## EDITORS' PREFACE

This volume arises from the second conference on the important contemporary theme of 'Population and Environment' organized by the Comité International de Coopération dans les Recherches Nationales en Démographie (CICRED) with the support of the International Union for the Scientific Study of Population (IUSSP) Committee on Population and Environment and the International Institute for Applied Systems Analysis (IIASA). The conference was held during two and a half days from 24 to 26 November 1993 at IIASA in Laxenburg, Austria.

This book is not a report of the conference. The conference was specifically designed for the participants to present papers on the research progress made by their demographic centres on the theme of population and environment during the two years since the first CICRED conference on 'Population and Environment' held during 7-9 November 1991 at the Université Catholique de Louvain-la-Neuve, Belgium (see CICRED, Population and Environment, Paris, 1992, 63pp.). Although the chapters in this book have been written by some of the 31 participants at the Laxenburg conference, including all members of the IUSSP Committee, not all of the participants have contributed chapters. Moreover, most chapters reflect individual concepts and research rather than the work of their research centres, which vary greatly in size, orientation and disciplinary complexity. In consequence, it is hoped that the volume has more coherence than a mere conference report.

On the other hand, recognition has to be given to the stimulus of the conference held at the excellent headquarters of IIASA at Laxenburg and admirably arranged by Wolfgang Lutz as local organizer ably supported by Marilyn Brandl and Judith Albert. Léon Tabah acted as President of the conference and John Clarke as Co-ordinator - hence their editorial responsibilities. Of the 31 participants, seven were from the active population-development-environment research group at IIASA, five from the USA, three from CICRED, two each from Belgium, Brazil, France, India, Indonesia and the United Kingdom, and one each from Mali, Mexico, Poland and Sudan. About one-half of the participants had attended the Louvain-la-Neuve meeting, but geographical distribution of participants was not quite the same as unfortunately for various reasons invitees from four other countries were unable to attend. To everyone involved in the conference, the editors express their heartfelt thanks for their cooperation and collaboration, and hope that this volume is a useful contribution to the growing literature on population-environment-development interrelationships.

The editors wish to give their special thanks to Mayssa Powell of the Centre for Overseas Research and Development (CORD), Geography Department of Durham University who undertook the arduous secretarial task of harmonizing the various submitted texts, and to Arthur Comer, David Hume and Steven Allan of the same Department who improved greatly a number of the figures. They are also most grateful to Hartati Ayrat of CICRED for all her help in facilitating the two conferences and this volume.

John CLARKE and Léon TABAH  
November, 1994

## AVANT PROPOS

La relation entre population, environnement et développement est d'une telle complexité que le sujet même est fréquemment négligé, sous prétexte que des relations simples et stables ne peuvent être clairement décelées. Le sujet tend à être négligé alors même que la conciliation entre croissance démographique encore rapide et développement véritablement durable est un défi majeur des prochaines décennies. Les ressources en patrimoine génétique, en terre et en eau suffiront-elles pour satisfaire les besoins des générations futures? La croissance économique que les pays en développement souhaitent la plus forte possible ne risque-t-elle pas d'aggraver sérieusement la dégradation de l'environnement? Le progrès technique, qui a permis d'échapper à la « trappe malthusienne » ne génère-t-il pas lui-même d'autres problèmes écologiques? Autant de questions auxquelles l'humanité est confrontée et doit apporter des « réponses » c'est à dire des actions susceptibles d'infléchir des tendances lorsqu'elles s'avèrent inquiétantes.

La complexité des relations entre population, environnement et développement tient notamment à l'existence de nombreuses interactions, à la sensibilité des relations à l'échelle d'observation, à l'importance du contexte et des comportements face à la production et à la consommation. On ne peut ignorer que la croissance démographique rapide accroît la pression sur l'environnement mais les sociétés gèrent de diverses manières cette pression. La qualité des sols et leur plus ou moins grande fragilité, notamment, permettront un accroissement plus ou moins important des densités. Les relations entre population et développement ne se présentent pas dans les mêmes termes à une échelle locale et globale. Le lien entre accroissement de la population, pauvreté et déforestation peut être clairement établi dans un espace donné sans que les conséquences pour l'environnement global de la déforestation puissent être vraiment précisées. Les modes de production et de consommation déterminent l'effet final sur l'environnement d'une multiplication des habitants de la planète. Selon le type de progrès technique incorporé à la croissance économique, selon le degré d'urbanisation et ses formes, un équilibre population-ressources respectueux de l'environnement sera maintenu plus ou moins aisément dans les différents pays du monde.

Sujet complexe à l'origine d'un défi majeur, les relations entre population, environnement et développement doivent faire l'objet d'une expertise renforcée. C'est d'ailleurs ce que recommande l'*Agenda 21* dans son chapitre V. Le CICRED ne peut par conséquent que se réjouir de la publication de réflexions riches et diverses sur ce thème. Et ceci d'autant plus que ce thème figure parmi les « orientations démographiques prioritaires » qu'il s'est définies pour les prochaines années.

Cet ouvrage qui aborde le thème population, environnement et développement d'une manière intégrée est une contribution d'importance. Il ouvre de nombreuses pistes prometteuses pour l'avenir.

Philippe COLLOMB et Jacques VÉRON

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# CHAPTER 1

## INTRODUCTION

**John I. Clarke**

*(North Durham Health Authority, U.K.)*

As mentioned in the Preface, this volume follows from two international conferences about research into the interrelationships between population and environment, at which researchers from many different demographic centres around the world discussed research fields and research progress. Some of the papers presented are included in this volume; other papers are individual studies reflecting personal approaches rather than collective research. It is worthwhile, therefore, to record how understanding about this research field evolved during the two CICRED conferences.

### 1. Recap of Louvain-la-Neuve Conference

#### 1.1. Background Issues

The meeting organized by CICRED at Louvain-la-Neuve in Belgium in November 1994 explored the vast diversity of population-environment (P-E) interrelationships within the world, which may be examined at a variety of levels from the local to the global (CICRED, 1992). P-E diversity arises from the multiplicity of populations with differing distributions, densities, dynamics and compositions; and the plethora of environments, reflecting the varying influences of factors such as continentality, latitude, altitude, climate, vegetation, geology, soils, slope and drainage. The P-E diversity also arises from a considerable number of intervening political, social and economic variables (e.g. policies, cultures, technology, institutions, development, consumption, trade) whose variations greatly affect the perceptions and utilization of environments by populations.

Stress was laid on the two-way nature of P-E relationships – that environment influences population and that population influences environment – although this is a simplistic view. With the passage of time, there has been great growth in population, technology, consumption and human-induced environmental changes overtaking – in the more developed world at least – many of the environmental constraints imposed upon humanity. Low densities and low consumption of early societies had local impacts, responding to environmental conditions more than altering their environments. With the growth of agriculture, industries, transportation, energy use, services, cities and population, human impacts have been transformed not only locally but also globally. The evolution of a global economic system with transcontinental movement of resources has greatly affected the global ecosystem, its lands, seas, atmosphere and biosphere.

Since the middle of this century, the growth of global awareness, arising from dramatic changes in transportation, telecommunications, transnational production, trade, travel

and tourism (Alger, 1988) and the emergence of the space age, has attracted mankind's attention to global issues – world population growth, urbanization, rural depopulation, income inequalities, gender inequalities, environmental degradation, ethnic conflicts, and flows of refugees – and increasingly on the interrelatedness of processes and phenomena, in particular global environmental change (GEC). Scientific attention has been focused upon the main disturbances in natural physical systems and their potential effects (Jacobson and Price, 1990) – climate change, ozone depletion, acid rain and loss of biodiversity – as well as on the human systems causing such phenomena: fossil fuel consumption; biomass fuel consumption; land use change; agricultural activities and halocarbon production and release. Public attention, however, has often been drawn to the links, sometimes direct but generally more indirect, between population growth and environmental change although the links have often been portrayed in a facile and over-simplified manner. It is the exploration of those complex links which was the focus of our attentions at Louvain-la-Neuve, especially as the interrelationships of demographic, economic and ecological processes have been inadequately researched.

The global rates of population growth and development – aggregates of immensely diverse local rates – are now so rapid that there is much anxiety about the future, when the pressures of population upon the environment will be much greater. One certainty is that there can be no simple correlation between population, development and environment, as their patterns have diverse influences and there are considerable difficulties of scale linkage. Whereas demographic transition in more developed countries (MDCs) was associated with rapid economic development, especially industrialization and urbanization, in less developed countries (LDCs) it has been less caused by economic development than by social and political factors. On the other hand, many of the major environmental problems in the world today arise from the enormous resource demands of the MDCs or from upsetting the delicate balance between population numbers and many fragile environments in LDCs, particularly the arid and semi-arid lands, tropical forests and over-populated mountains and coastal zones, where natural or man-made disasters are common.

## **1.2. Proposed Research Fields**

With this background in mind, at Louvain-la-Neuve there was wide-ranging discussion by CICRED centres about research themes in P-E interrelationships; from those who emphasized the need to focus upon the environmental impact upon demographic dynamics to those who considered that the key issues, which had been much neglected, were demographic influences upon the environment. An intermediate group stressed the need for integrated approaches, and that the field necessitated interdisciplinary research. In general, it appeared that previously CICRED centres had analyzed more the effects of population upon environment than the environment upon population.

In his introductory note as Coordinator of the conference, John Clarke had submitted an initial list of proposed broad research fields:

1. P-E data issues
2. Population concentration
3. Identification and analysis of P-E crisis areas
4. P-E relationships in settlement systems
5. Migration in P-E relationships
6. Health and environmental degradation
7. Fertility and the environment
8. Women and children in the environment

Although by no means a comprehensive taxonomy of research areas, it provided a basis for discussions, especially as most were already being tackled by the small sample of CICRED centres represented at Louvain-la-Neuve. However, discussants amplified this list by an even longer one:

1. P-E modelling
2. P-E policies
3. P-E education
4. Environmental quality and quality of life
5. Perception of P-E relationships
6. P-E relationships in historical perspective
7. Impact assessment of positive and negative, planned and unplanned effects of P-E relationships
8. Analysis of energy/water consumption in P-E relationships
9. P-E projections
10. P-E sanitation and community health
11. P-E relationships under different occupational and family systems
12. Field analyses of the Malthusian and Boserupian hypotheses

Views about these 20 proposed P-E research areas were varied, and in the course of discussions a number of notable general points were made:

- importance of the time dimension;
- crisis and long-term issues should be examined under the 3 key demographic variables: fertility, mortality, migration;
- crisis issues are region and country-specific;
- regional strategies should be in the context of global strategies;
- researchers should be aware of planning strategies for both population and environment;
- concept of sustainable development important, but not easily defined;
- large-scale modelling not very useful;
- need to define demo-ecological indicators;
- emphasis should be given to micro-studies of P-E relationships;
- methodology required with both quantitative and qualitative approaches, a theoretical framework and guidance on use and acquisition of data; and
- literature review necessary.

Eventually, it was decided to give further consideration to three broad research themes:-

- A. theoretical framework and methodology
- B. crisis issues
- C. long-term issues

which were examined in more detail by three working groups.

A. The group concerned with theoretical framework and methodology produced a number of descriptive analytical models in particular (a) relating P-E to development (Fig. 1) and (b) identifying the relationships between population dynamics and the environment (Fig. 2). They also proposed the following three groups of research issues:

1. Population, territorial distribution and environment: concentration, settlement systems, in-migration and out-migration, coastal areas, communities, etc.
2. Population, development and environment: the impact of work processes and technologies in the primary, secondary and tertiary sectors.
3. Population, welfare and environment: education, communication, health, nutrition.

B. The working group looking at crisis issues distinguished between the macro, meso and micro levels, pointing out that micro-level issues can escalate to higher levels.

They also grouped them into six broad categories according to their relatedness:

1. Mega-cities and conurbations
2. Natural disasters and catastrophes
3. Drought and desertification
4. Deforestation
5. Agriculturally caused disasters
6. Global issues

They suggested that these issues should be studied with a view to determining how populations contribute to the processes involved in the issues through their size, growth, concentration etc. and how they are affected by and respond/adapt to catastrophes and disasters. The first four were recommended as key crisis issues for proposed research by CICRED centres along with the growth of contrasting consumption patterns.

C. As for the Working Group looking at long-term research issues in P-E relationships, they found the Malthusian and Boserupian positions central to their discussions but some found these too dichotomous and polarized. They went on to specify seven themes, examining the effects of:

1. Rising population on land management and agricultural productivity
2. Rising population on water management and availability
3. Climate changes on long-term population distribution
4. Migration and urbanization on the environment

5. Environmental change on migration
6. Pollution and environmental degradation on maternal and child morbidity and mortality
7. Population growth on local biodiversity through increasing crop specialization and/or loss of wildlife habits.

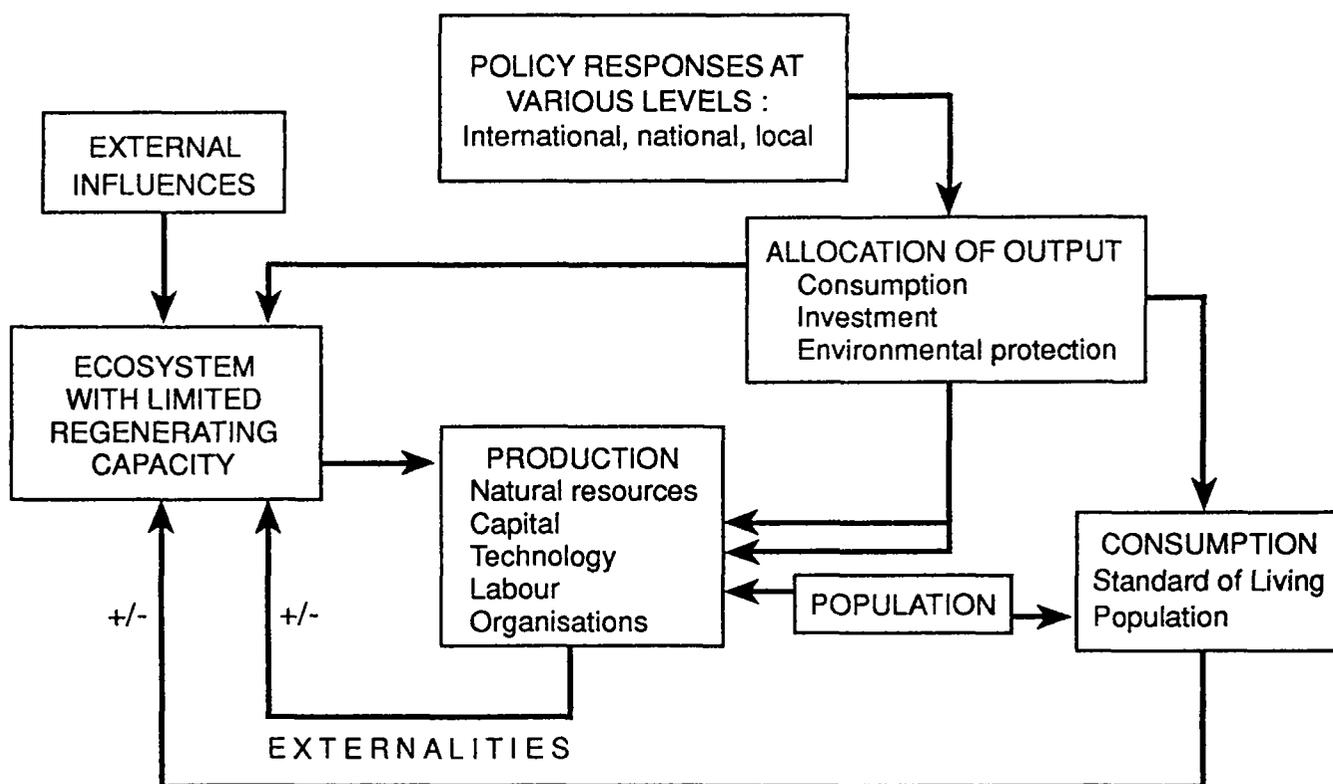


Fig. 1. Model relating P-E to development. Natural resources, together with other factors, enter the production process. Population affects directly consumption and labour.

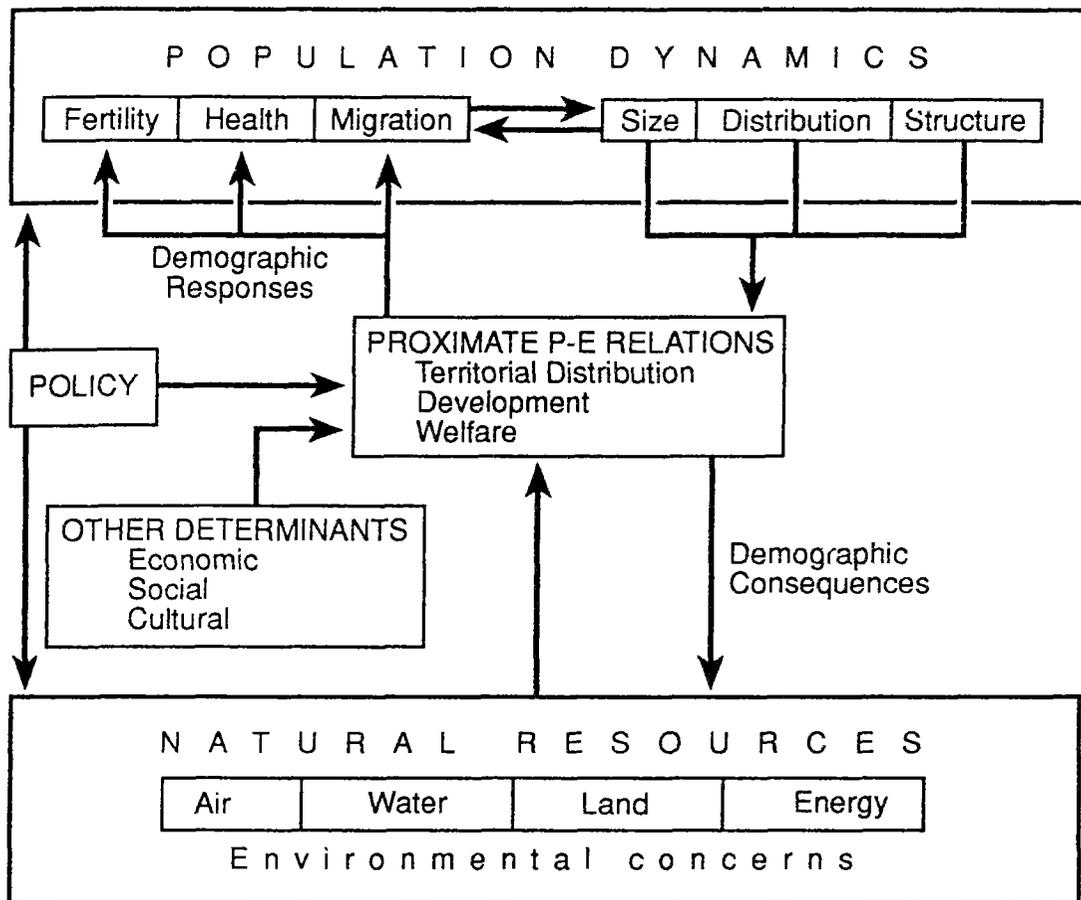


Fig. 2. Model identifying the relationships between population dynamics and environment, some of which are direct and others indirect through a complex system of intermediate variables and mechanisms.

These various research themes identified at Louvain-la-Neuve were recommended to CICRED centres interested in P-E research, without of course being mandatory. Some were already being studied, and in addition the IUSSP Committee on Population and Environment, which was well represented at Louvain-la-Neuve, had already decided that apart from its overall concerns with P-E relationships, explored at its joint meetings with the British Society for Population Studies (BSPS) at London and Oxford in 1991 and 1992 respectively (Zaba and Clarke, 1994) and subsequently at Montreal in 1993, it would examine particularly the following:

1. Population and deforestation (Campinas seminar, 1992)
2. Population and environment in arid regions (Amman seminar, 1994)
3. Population and environment in heavily industrialized regions (Warsaw/Cracov seminar, 1994)
4. Gender-environment issues (Dakar seminar, 1993 and Oaxaca seminar, 1994 in collaboration with the IUSSP Committee on Gender and Population).

Moreover, some members of the IUSSP Committee were also involved in the International Social Science Council (ISSC). Working Group on Population Data and Global Environmental Change which had been commissioned to look at the manifold problems of linking population and environmental data (Clarke and Rhind, 1992).

## **2. Other Major Issues**

Although wide-ranging and a considerable stimulus to research activity in the field of P-E relationships, the Louvain-la-Neuve conference was not exhaustive of such a broad research field, partly because CICRED centres tend to have specifically national viewpoints, and partly because the debate is constantly moving on. In focusing upon research topics, a number of major issues received relatively little attention in these discussions, given their importance in the literature. Such issues include:

- diversity of human impacts upon the environments;
- population and disasters, discontinuities and limits;
- population and resource depletion;
- the concept of sustainable development; and
- poverty and the environment.

### **2.1. Diversity of Human Impacts on Environment**

Among demographers concerned with P-E relationships, there is perhaps an inevitable tendency to focus upon a few of the more striking examples of GEC, and this was so even at the Louvain-la-Neuve meeting. However, the range, variety and local/regional/global significance of human impacts upon the environment is immense. Not all are negative, and not all may be lumped under the crude umbrella of 'environmental degradation', which is usually undefined and often ambiguous. Some of the more important impacts are listed below, amplifying an initial list made by Goudie (1984:312-3):

- Animal and plant dispersal
- Animal and plant domestication
- Reduced biodiversity
- Conservation of species
- Tropical deforestation and secondary rainforest formation
- Origin of mid-latitude grasslands and savannas
- Expansion of deserts
- Development of Mediterranean scrub
- Soil erosion
- Tropical soil infertility
- Salinization of soils through irrigation
- Altered infiltration rates
- Groundwater depletion
- Changes in river flows, flooding, channels and sediment
- Water shortages
- Pollution of rivers, lakes, seas and oceans
- Eutrophication of lakes
- Rising sea levels
- Global warming
- Ozone depletion
- Acid rain
- Atmospheric pollution
- Urban heat islands
- Waste disposal
- Quarrying and mining
- Land subsidence
- Initiation of mass movement on slopes
- Coastal erosion and deposition

The impact of humanity, whether deliberate or inadvertent, is not the only cause of such environmental changes. Environments are constantly changing, but vary in sensitivity and the changes take place over millions of years. Human impact is geologically recent, but its acceleration has been recorded and analyzed in detail only during the last few decades when improved instrumentation has become available. Not surprisingly, therefore, environmental data are historically limited, and it is difficult to determine the relative significance of human and natural causes in changing the environment. As Goudie (1984: 314) has emphasized, different processes can lead to the same result – the principle of equifinality – and he gives examples of pavements, pediments and desert crusts.

Goudie (1993) has also emphasized the huge areas of uncertainty about future environmental change particularly in biodiversity, atmospheric chemistry and climatic change. He finds the roots of this uncertainty in a variety of factors:

- complexity of natural systems;
- existence of thresholds and non-linear response to change;
- imperfection of models (e.g. general circulation model);
- lack of knowledge about background levels and trends of various phenomena;
- potential role of catastrophic or extreme events;
- potential role of unsuspected mechanisms (like CFCs);

- problem of predicting crucial factors (e.g. precipitation) which affect other environmental phenomena; and
- problems of definition (e.g. deforestation, desertification).

An immense effort is being made to reduce this uncertainty by new models, improved observations and increased research, but perhaps Glantz (1993) is correct when he asserts that "there will always be scientific uncertainty surrounding environmental issues". Hence the debates surrounding the quantitative projections concerning such issues as global warming, ozone depletion and desertification as well as the earth's limits to population growth.

## **2.2. Population and Disasters, Discontinuities and Limits**

Although some consideration was given to the topic of disasters at Louvain-la-Neuve, its significance was perhaps rather neglected given that the 1990s have been declared by the United Nations as the International Decade for Natural Disaster Reduction (IDNDR).

Disasters are not readily definable, but generally they are accepted as sudden catastrophes affecting human life. Unfortunately, there is no widely accepted definition of the time-scale or size of such catastrophes (Clarke, *et al.*, 1989).

Environmentalists have laid great stress upon natural hazards, such as earthquakes, volcanoes, hurricanes, tidal waves and droughts. Disasters, however, result not only from environmental extremes but also from a large number of human actions – technological, social, economic and political – affecting the environment to a greater or lesser extent: warfare, over-cultivation, overgrazing, deforestation, excess population pressure, pollution, mining, quarrying, etc. Frequently, a combination of various environmental and human factors trigger disasters, as for example in the Sahel of West Africa, the Horn of East Africa, the deltas of Bangladesh and the mountains of Nepal where populations are poor and ecosystems are particularly fragile.

Disasters vary greatly in their human cost, and generally man-made disasters are much more devastating and more widespread than natural disasters. They are also more common, not only because we hear and see them more often on our television screens, but also because population growth and technological change have put pressure on places incapable of sustaining it.

This has led to the concepts of environmental discontinuities/thresholds at which there is an abrupt "downturn in the capacity of environmental resources to sustain human communities at current levels of well-being" (UN/ESC/E/CONF.84/PC/4), and there is a 'jump effect' whereby the ecosystem becomes severely disrupted. The effects of acid rain upon coniferous forests and fresh-water systems in Europe and North America are cited as examples. Fuelwood shortages affecting perhaps a billion people in developing countries are another.

Discontinuities naturally raise the vexed question of limits, so heatedly discussed usually at the global level, partly because they are easier to examine in a closed system than in an open one. Generally limits have been discussed in terms of economic viability rather than environmental degradation; the ability of an area to support a population with the resources available. Hence the terms 'optimum

population' and 'overpopulation' have been popularly and loosely used, specially beloved by those who see things as clear-cut.

The concept of 'carrying capacity' is also concerned with limits, and is often referred to as critical carrying capacity. Derived from the work of biologists, the concept has come to mean not merely population-supporting capacity but also population-sustaining capacity, i.e. the ability of an area to sustain a population over a long period without major environmental discontinuities or irremediable damage to the environment. In short, the concept has become more environmental and less economic. It is suggested that populations must learn to live off the 'interest' of environmental resources rather than their 'principal' (UN/ESC/E/CONF.84/PC/4), because particularly in many parts of the developing world rapid population growth means that carrying capacities are exceeded, especially where renewable resources like fisheries and forests, upon which there is heavy dependence, are not easily replaced.

Carrying capacities have been frequently calculated for the world as a whole, but the diversity of findings - from 7.5 to 50 billion - is so great that they are regarded scientifically with much scepticism. At a much more local scale, calculations have been often made for rural populations in developing countries heavily dependent upon agricultural production and natural resource stocks, whose depletion could cause problems. More difficult is the calculation of carrying capacity for countries, because the growth of the global economy has made them, especially the MDCs, less and less dependent upon their own resource stocks and more and more upon those of the rest of the world; the G7 countries and the 'tigers' of the Pacific rim are obvious examples. Many rich countries (e.g. Japan, UK) have relatively few natural resources, while many poor countries have many (e.g. Sudan, Zaire).

Resource depletion is therefore a global problem, an aggregation of growing resource use and misuse, and cannot easily be related to population at national level as neither resources nor populations are really constrained.

### **2.3. Population and Resource Depletion**

Another reason why the ratio of population growth to resource depletion is not a simple one is that resources acquire economic significance only as a function of technological knowledge. That knowledge has increased phenomenally, especially since the Industrial Revolution, and it constantly gathers speed. Increased technology has led to great expansion of the resource base as non-renewable and renewable resources are brought into use; changes in energy demand and use exemplify this well, as seen in the movement from fuelwood to wind and water power, coal, hydro-electric power, oil, solar power and nuclear power. Increased technology has also been associated with dematerialization (i.e. the substitution of bulky and costly materials through sophisticated design methods), increased technical efficiency (e.g. engines) and the production of new materials (e.g. polymers). In particular, during the past few decades immense progress has been made in reducing the relative amount of energy needed for economic growth, especially in the MDCs but also in a number of LDCs like China, Brazil and the Philippines.

In consequence, strategic technologies are gradually replacing strategic materials in the MDCs, where heavy infrastructures are well developed; in most LDCs, however,

where basic infrastructures are limited, the demands for development are different, for they need both the technologies and the materials. Inevitably, there is a considerable problem of technology transfer, but the effort to raise the living standards of the rapidly growing populations of the LDCs will pose major problems of resource provision and depletion.

Energy efficiency improvement is vital to reduce pressures on environments with minimal net economic or social cost. There are, however, great variations from improving the efficiency of a power plant to that of household energy use, and usually there are greater short-term benefits to poorer people in effecting the latter. Certainly, the whole field of energy efficiency is vital, not only in the context of resource depletion and environmental degradation but also in the development of the developing countries.

#### **2.4. The Concept of Sustainable Development**

Although widely used, the terms sustainable development, sustainable use and sustainability received scant attention at Louvain-la-Neuve despite (or perhaps because of) their fashionability. Sustainable development is of course a grand ideal, but is sometimes scorned or discarded as too vague and ambiguous. It is rather elusive of quantifiable definition – globally, nationally, locally and for specific resources – and so putting it into practice is difficult. Unfortunately, individual, community, national and global interests tend to conflict, and too often society at large pays for the pollution and self-interest of the few.

Different specialists also have different views about what is to be sustained. While biologists stress the preservation of the environment and biosphere, economists stress economic growth and consumption levels, and sociologists stress demands on the environment that are culturally determined. Thus, some interpretations are more environmental than others.

The great value of the concept is that it may be an integrative approach requiring a whole basket of measures, among which efforts to reduce fertility rates are vital, especially through improving the social status, health and education of women. As Tetrault (1992: 31–5) has stated for the Canadian International Development Agency (CIDA), "establishing a sustainable relationship between people, resources, environment and development hinges upon several commitments such as:

- Tackling poverty and the debt issue
- Planning the human family
- Investing in people
- Achieving food security and preserving soils and forests
- Caring for biodiversity, water and oceans
- Making sound energy choices".

#### **2.5. Poverty and the Environment**

Poverty is a major factor in P–E relationships in developing countries, at every level from the individual and household upwards. A great deal of environmental degradation in the LDCs results from poor people searching for the basic essentials of life: food,

water, fuel and fodder. In growing numbers they are pressing upon the margins, destroying the resources upon which they depend and assisting in the processes of soil erosion, desertification, deforestation and water shortage. In the least developed and poorest countries, notably of Sub-Saharan Africa, poverty is a critical factor in out-migration to cities and in environmentally induced migration, sometimes called environmental/ ecological/resource refugees, though none of these concepts has any standing in international law (Richmond, 1993). The poor also suffer from unhealthy environments, lacking adequate sanitation, housing, water supplies and waste disposal, and so they are greatly affected by many of the environmental diseases (e.g. TB, diarrhoea, trachoma, worms, respiratory infections) which have been drastically diminished in MDCs.

With continuation of present fertility declines in the South and economic growth in a number of newly industrializing countries in populous Asia, some expect that absolute poverty should diminish in the 21st century, though relative poverty and inequality may increase (Gilbert, 1993). Although the poor will continue to be mostly rural, the numbers living in cities are rising fast, ensuring that P-E problems in cities will also increase. Without major improvements in the infrastructure of LDC cities many environmental problems will become increasingly intractable.

Stress has been laid on the need to use the synergism between rapid population growth, the persistence of poverty and environmental degradation by targeting the poor, to assist them by making environmental investments (e.g. reforestation, irrigation, terracing) which would be in their long-term interest, as well as investments in education and health which would eventually promote demographic transition.

It is this synergism which is valuable in the development of population-environment education which is less narrow than either population education or environmental education and is capable of linking local and global issues at various levels in the educational curriculum (Clarke, 1992).

### **3. Changing Attitudes**

#### **3.1. The Rio Conference**

During the period between the CICRED conferences at Louvain-la-Neuve and Laxenburg the United Nations Conference on Environment and Development (UNCED) at Rio in 1992 revealed the yawning and perhaps widening gap in perceptions of the P-E problem between MDCs (the North) and LDCs (the South), however imperfect that dichotomy. It was fuelled (a) by the reluctance of the rich countries to assist the poor countries in coping with their more difficult environmental and developmental challenges, by means of debt relief, technology transfer and open trade; and (b) by their persistent emphasis upon population control programs for LDCs, which many (especially women) in LDCs see as sacrificing their reproductive rights in order to preserve the welfare of rich children in the MDCs (Merrick, 1993). On the other hand, perhaps the real difference at Rio was not between the North and the South, or even between the governments and the NGOs, but between those who feel that the environmental crisis could be solved by technology and better pricing of natural

resources and those who believe that a major shift in values is required and a change in the world's economic system giving greater emphasis to the health and livelihood of all.

Attitudes of governments to the population and environment elements in P-E relationships therefore differ considerably. Consensus views of international groups of experts on the interrelationships of population, environment and development have generally concluded that "in many contexts, detrimental impacts on the environment would best be reduced by a combined strategy of slowing population growth, rationalizing population distribution, alleviating poverty, lessening environmentally dangerous consumption patterns and promoting the application of appropriate technologies and management regimes"... "to achieve sustained economic growth as well as sustainable development, in particular by replacing fossil fuels with renewable energy sources and providing a more productive use of increasing scarce water resources" (UN/ESC/E/CONF.84/PC/R:4). In short, a holistic approach would undoubtedly have beneficial effects to the health of the human species and to its survival among the changing natural ecosystems (McMichael, 1993).

### **3.2. Discussions at Laxenburg**

Wide-ranging discussions at Laxenburg revealed that while a comprehensive research analysis of the interaction between population, development and environment, in which development is seen as the intermediary between population growth and environmental change, was supported strongly it was not the only view. This approach was seen by some to be most appropriate at more local levels, from household to nation, than at global level. Others proposed a more modest research agenda which would focus on the effects of environmental degradation, mainly through health and migration.

Similar divisions of opinion were expressed over the need for a general framework for research. Some, especially IIASA colleagues, supported the idea, especially to facilitate quantification; others felt that a general framework was not usable everywhere, because the strength and direction of the interactions between population, development and environment as well as the characteristics of these elements vary so much around the world, and because other external factors may be important. They suggested a plurality of approaches.

There was also lively discussion over the relative merits of disciplinary and interdisciplinary research. IIASA researchers again supported wholeheartedly the latter, despite the acknowledged difficulties of practising it, emphasizing that global problems cannot be examined in separate little compartments. Others stressed that demographers should focus more on the population element in P-E studies, especially as most demographers are ill-equipped to deal with environmental issues.

Discussion also ranged around the utility of simulation models, which users regarded as a tool and a method rather than a framework. Others were not persuaded by their general value.

An area where there was much more agreement was the need to put development (D) back into P-E studies, for most felt that development formed a triad (P-D-E) with

population and environment, the targets being sustainable development and improved quality of life.

Certainly CICRED centres are well positioned for research in this area, and it was suggested that CICRED's role should be identified on the assumptions that its multinational character favours a comparative approach, that it is demography-driven and policy-driven, and that the centres are often multidisciplinary and interdisciplinary. On this basis CICRED centres felt that the following topics pose particular research interest for students of population:

- Long-term collaborative work on comparable ecosystems;
- Development of methodology, such as rapid assessment and geographical information systems (GIS);
- Fertility and the environment in the context of sustainable development;
- Health and the environment;
- Migration and the environment;
- Urbanization and the environment, especially in a regional context;
- P-E aspects of growing concentration of population;
- Quality of space per capita;
- Linkages between urban and rural P-E problems; and
- Micro-studies of families/households and environment.

They are also aware that such research should be action-orientated.

#### **4. Contents of this Volume**

This volume presents a selection of papers presented at Laxenburg along with a number of others which are revised versions of research reports submitted there on behalf of centres. The range is by no means comprehensive of the range of research undertaken by CICRED research centres, but it incorporates a considerable variety of issues of general and specific interest, including theoretical and methodological matters, varied perceptions and policies, mortality and health in urban and industrialized environments, as well as land use and carrying capacity.

The papers do not fall naturally into clear-cut sections, but the first part of the volume is devoted to concepts, theories and methods of analysis and opens with a wide-ranging study of the interrelationships between population, environment and development by Léon Tabah (Chap. 2). He explores those ideas which are generally accepted, looks at the part played by population in environmental degradation, and then considers the future of world population and its consequences upon the environment. It is a valuable overview of an extensive literature, and tries to answer many of the major questions in the population, environment and development debate.

At the Laxenburg conference, Léon Tabah's opening address stimulated a useful discussion on the value of interdisciplinary studies and methods, a theme taken up in Chapter 3 by Nathan Keyfitz, then a resident researcher at IIASA, who postulates an interdisciplinary model based upon employment and unemployment as an approach to the problem of building a productive, sustainable and equitable society. Keyfitz gives emphasis to the underlying issues under discussion, including the dangers of utopias

based upon politics alone and the 'drive for justice' in LDCs, engendering the rise of fundamentalism.

Marc Debuissou and Michel Poulain in Chapter 4 also favour an interdisciplinary approach, stressing the inseparability of the concepts of environment and human population and their complex interactions, both impacting upon each other. In particular, they examine the influence of specific demographic characteristics.

George Martine (Chap. 5) points out that the relationships between population and environment have generated much controversy and debate, but little clarity. In an effort to contribute to clarification, he provides a brief review of the main schools of thought; proffers a framework for the identification of conditions under which given types of population dynamics generate critical environmental consequences; argues that population – environment interactions must be analyzed in terms of economic globalization; and claims that this shifts the locus of environmental concern to a greater emphasis on the densely populated urban areas.

Jean-Philippe Peemans (Chap. 6) also explores the interlinkages between population, environment and development at various levels, and how they have been differently perceived over time. He stresses that they have to be tackled in a dynamic and historical approach, and that global problems can actually be understood at a more local level, where peoples in communities have to be seen as actors in the quest for a better balance of population and environment. States have to help communities to organize themselves, in contrast to past modernization theories which regarded traditional societies as immutable. Unfortunately, the dominant model of development at global level leads to much local environmental degradation.

Wolfgang Lutz in Chapter 7 explains how he and his team of researchers at IIASA have developed a valuable operational analytical framework for studying the effects of different population trends on socio-economic and environmental conditions, and how they used this Population-Development-Environment (PDE) approach in a major project on population and sustainable development in the Indian Ocean island of Mauritius, which experienced the world's most rapid national fertility decline around 1970. In particular he stresses the importance of long-term decision-making and investment in human capital, especially in the status of women.

Michel Picouet in Chapter 8 explains how he and his various colleagues in five different Tunisian and French research institutions have tackled the problem of analyzing the relationships between population and natural environment in the Tunisian countryside by the DYPEN programme. It does not bring results which are assimilable everywhere in Tunisia but has been valuable in examining arid, semi-arid and forest regions.

The second part of the volume comprises a number of chapters which focus particularly upon polls, perceptions, attitudes and policies. It opens with a study by J. Mayone Stycos, who argues in Chapter 9 that scholarly productivity on the environment has grown faster than that on population, while treatment of P-E interrelationships has been limited. International polls that have included many questions about environmental attitudes have included far fewer on population. The few surveys on population attitudes have ignored the environment. The World Fertility Survey (WFS) and the Demographic and Health Survey (DHS) are regarded as poor models for P-E research, while others also have limitations. Stycos makes out a case

for a new multinational public and elite opinion survey on population and environment in order to facilitate policy formation.

Ismail Sirageldin in Chapter 10 explores the difficult area of relationships between population dynamics in LDCs and political conflict. He comes to the conclusion that they have a significant effect mainly indirectly through proximate factors such as the growing scarcity of renewable resources, reduced economic productivity, out-migration or the weakening of state authority. He stresses that population change may reduce the adaptive capacity of countries and thus induce conflict, especially where minorities and inequalities exacerbate the situation. He uses a number of case studies from Bangladesh/Assam, Mauritania/ Senegal and the Middle East to exemplify the findings.

The next chapter (11) is devoted to a more specific study of population-environment policies in Mexico. Ligia Gonzalez Garcia de Alba explains how the National Population Council of Mexico has developed a spatial population distribution policy based on regional development criteria. Following detailed analysis, some 44 strategic micro-regions have been selected (from more than 200 identified) to encourage change in population distribution by taking advantage of their development possibilities within a framework of environmental protection. Most are coastal and a considerable distance from Mexico City and the northern border, but have their own central cities. It is an interesting example of an integrated policy-orientated regional study linking population and environment through economic activity.

Daniel Hogan in Chapter 12 discusses how there is a new urgency to the population-environment question in Brazil brought about by dramatic changes in social thought and in the importance of environmental issues. He tries to explain why there was such great initial resistance, and how the situation has evolved under the influence of recent political history and the debate on models of economic development. The rapidity of recent fertility decline has surprised everybody, as it was achieved without a national family planning programme and appears unrelated to economic growth.

Following the theme of P-E issues in LDCs, Keshari Thapa and Richard Bilsborrow in Chapter 13 assess the causes and environmental consequences of frontier migration in poor countries, using the results of their research in Nepal and Ecuador. Migration from highland to lowland prevails in both countries, stimulated by rapid population growth, unequal land distribution, lack of alternative employment opportunities and government resettlement policies, and this has been the proximate cause of deforestation. The desire for land is the main cause for migration, but there are important differences between the two countries, and they can learn from each other's successes and mistakes.

On another general policy-orientated theme, Hyacinth Ajaegbu in Chapter 14 adopts a local community approach to the study of population-environment interrelationships with reference to Africa, particularly Nigeria. In particular he presents a model which distinguishes five separate phases of population dynamics, resource use and environmental change, ranging from primitive balance and harmony through phases of change to either relative balance and sustainability or irreversible imbalance. He points out the great complexities in population-environment interrelationships, their diversity among different communities, and those groups which are particularly vulnerable to population-environment problems.

The next part of the volume switches to a number of studies which focus upon mortality/morbidity and the environment, especially problems associated with industrialized environments and mega-cities of LDCs. In Chapter 15 Daniel Noin stresses the methodological problems in linking mortality with the environment, especially because the causes of mortality are often multiple and it is difficult to isolate environmental factors. He shows that natural disasters have accounted for only 0.16 per cent of total estimated deaths during 1970–90, and that in MDCs the role of the environment in mortality has been generally overtaken by social and cultural factors, except in heavily industrialized regions such as those in Eastern Europe.

As an example of the latter, Alina Potrykowska in Chapter 16 examines the case of Poland, which is said to be facing an environmental disaster at a time of radical change in its national economic system when it has very little funds to do anything about it. Some 27 P–E crisis areas have been identified encompassing 11 per cent of the area and incorporating 35 per cent of the population. Poland is now reshaping its environmental policy to a broader goal of sustainable development, so that comprehensive environmental policies have to be developed and effective methods of implementing them.

India poses different problems of morbidity and mortality, but in Chapter 17 Parveen Nangia, Kamla Gupta, T.K. Roy and Rajiva Prasad present the graphic results of a survey of population and health in a 5km zone around the Rashtria Chemicals and Fertilizers (RCF) plant in Bombay where about 2.23 millions live, many suffering from chronic ill-health, especially the elderly. They make recommendations to mitigate suffering, to reduce the level of pollution and to meet catastrophes.

The contiguity of industries and population are not the only problem of Indian cities. In Chapter 18, Sudesh Nangia examines a squatter settlement of 1500 households in Delhi, including the consequences to the quality of the environment and the maintenance of basic services in neighbouring areas. It is a salutary reminder of P–E issues in mega-cities, when it is realized that Delhi is dotted with nearly 900 squatter settlements accommodating nearly 200,000 people.

Of course, the P–E problems of mega-cities are growing annually, and in Chapter 19 Djuhari Wirakartakusumah is concerned with how rapid industrialization in the urban centres of Indonesia attracts migrants, who come to live in slums because they cannot afford to live elsewhere. He reports on a study of a number of suburban residential areas which encourage people to relocate from the capital city, Jakarta, though they continue to commute daily to jobs there. He goes on to analyze why people migrate, their environmental and residential conditions and how the migrants perceived their environment. He concludes that major improvements in transportation and housing are vital, though his suggestion of putting housing close to industries may not be a satisfactory solution in the case of dirty industries.

Part IV is concerned with a selection of population–environment problems which reveal the diversity of the research field. Hassan Musa Yousif in Chapter 20 studies the relationship between population settlement patterns and the environment in central Sudan. On the one hand, there is a heterogeneous mix of rural settlements, reflecting historical, tribal, religious, political and environmental factors, as well as a considerable nomadic population. On the other is the influence of land, water and biomass fuel availability. The supply of water and rainfall permitted cash crop production to progress

against livestock and forestry, so that many rural people have been pushed to dry dune areas, where there is overgrazing and immense pressure on the environment. Obviously this is an area of considerable environmental fragility increased by rapid population growth.

Basia Zaba and Hilda Kiwasila in Chapter 21 examine in some detail the relationship between population growth in rural and urban areas of Tanzania and changes in domestic water supply during the intercensal period 1978–88, when there was a substantial decline in the population of households obtaining drinking water from piped supplies and from sources internal to their dwellings or compounds. In brief, they show that rapid population growth may be a contributory factor in this decline in urban areas, but it is not true for rural areas.

In Chapter 22, Riga Adiwoso–Suprpto considers the factors influencing land use cover change (LUCC) among six communities in three locations in Indonesia – in West Java, Irian Jaya and Flores. She examines the dynamic process of community decision-making regarding land use at the micro-level; how the community negotiates internal and external pressures for land use change through its value systems and institutional mechanisms. It is a study which is more data-driven than model-driven, and looks at the various driving forces for change.

Finally, in a very different research field Maurice D. Van Arsdol Jr and colleagues (Chapter 23) describe how local changes in sea level tied to climate and global change are expected to decrease the base of California's coastal zone available for settlement at a time when coastal population is increasing and a larger area is at risk from erosion and flooding. They are assessing the available coastal land base to support future population in shoreline areas, and project populations from 1990 to 2040. It is the last of a wide variety of contributions to our understanding of population–environment–development interactions.

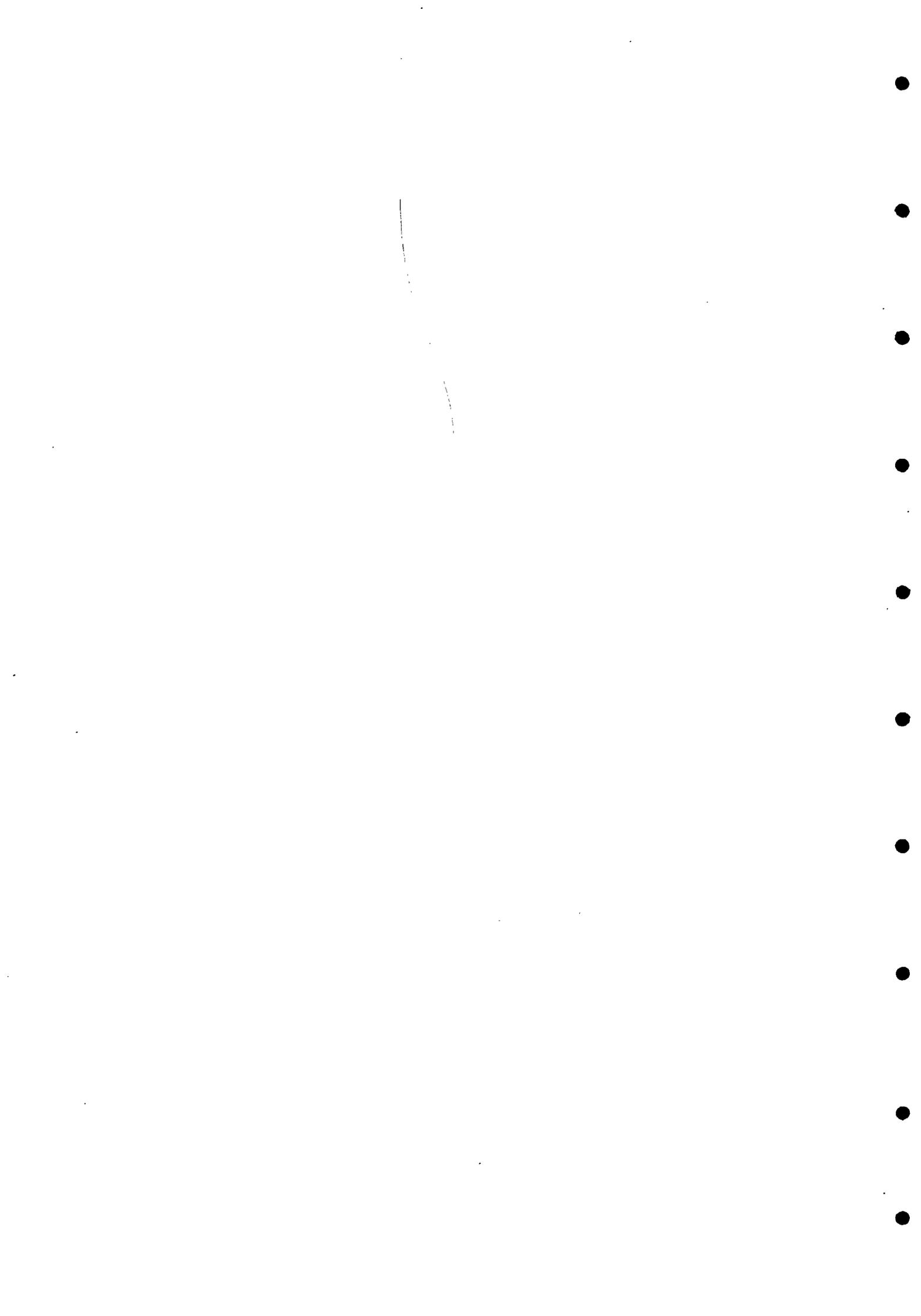
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**PART I**

**CONCEPTS, THEORIES AND METHODS OF ANALYSIS**



## CHAPTER 2

# LES INTERRELATIONS POPULATION-ENVIRONNEMENT-DEVELOPPEMENT: ETAT DE LA QUESTION ET PERSPECTIVES

Léon Tabah

*(L'ancien Président de CICRED)*

### 1. Quelques idées généralement acceptées

Commençons par quelques idées qui semblent recueillir l'assentiment de la communauté internationale des chercheurs, sans attribuer une hiérarchie entre elles.

#### 1.1. Les relations quantitatives, qualitatives, la notion d'irréversibilité

La première idée qui vient à l'esprit lorsque l'on aborde les interrelations entre la population et l'environnement est simple: la population ne cesse de croître tandis que l'environnement est limité, et au surplus se détériore, comme chacun en convient aujourd'hui. Le monde donne l'impression de se dégrader et de se rétrécir par rapport à une population dont la croissance ne connaît pas de répit. Mais il serait de toute évidence abusif d'attribuer entièrement la détérioration de l'environnement à la croissance démographique. Bien d'autres facteurs sont en jeu, souvent en conjonction avec la population, et nous verrons ce qu'il faut en penser dans le cours de ce rapport.

Les deux facteurs population et environnement sont fondamentaux, et comme tous les facteurs fondamentaux, ils doivent être analysés dans le très long terme. Nous devons nous sentir concernés dans cette analyse par la préparation non seulement du XXI<sup>e</sup> siècle, mais aussi du XX<sup>e</sup>.

Il y a entre la population et l'environnement de très nombreuses et complexes relations de type à la fois quantitatif et qualitatif que nous ne comprenons pas toujours très bien. Mais il est certain qu'arrive un moment où les changements quantitatifs induisent des changements qualitatifs. Cela conduit à la notion de seuil. L'accumulation de changements de l'environnement peut finir par entraîner des irréversibilités. L'exemple le plus cité est l'accroissement de gaz carbonique dans l'atmosphère qui, s'il continue au rythme de ces 25 dernières années, peut devenir tel que l'absorption naturelle par la photosynthèse des plantes et des océans pourrait ne plus suffire à maintenir un taux tolérable dans un avenir qu'il est impossible de prévoir. La capacité régénératrice serait épuisée.

Pour ce qui est de la démographie, une croissance continue très élevée, et constante, disons un taux supérieur à 2 pour cent, pourrait rendre le monde inhabitable au bout de quelques décennies, et des mesures de conservation prises en cours de route ne pourraient suffire à redresser la situation. Pour Malthus, au-delà d'un certain point, une croissance démographique crée de la pauvreté. Il est donc aussi des évolutions

démographiques qui peuvent créer des situations irréversibles. Un exemple est le vieillissement de toutes les populations, dont on ne voit pas le retournement avant très longtemps. Des mesures prises trop tardivement ne pourraient empêcher une évolution qui se développerait inexorablement.

## **1.2. La qualité de la vie, notion toute relative**

La détérioration de l'environnement conjuguée à un accroissement excessif de la population peut entraîner à son tour des changements dans la qualité de la vie des populations. L'environnement est un des facteurs essentiels de la qualité de la vie. Certes, cette dernière n'est pas une donnée immédiatement objective. C'est la perception que l'on a de notre vécu. Elle est une donnée subjective, mais aussi fortement influencée par notre milieu, et donc hautement variable d'une population à une autre. Il faut faire un grand effort par la pensée pour saisir ce que ces mots signifient dans le jugement d'un habitant d'un pays riche et dans celui d'un habitant d'un pays pauvre. La qualité de la vie pour le premier peut être compromise par une simple atteinte au confort, alors que pour le second la notion même de confort est dérisoire, voire absente, et la priorité majeure est de faire face à des situations d'urgence et de subvenir aux besoins fondamentaux immédiats, même si cela a des conséquences négatives sur le milieu. Les horizons diffèrent entièrement. Nous devons constater une fois de plus que les pays riches et les pays pauvres n'ont pas les mêmes problèmes à résoudre, et que leurs visions de ces problèmes sont très différents. Il serait non seulement injuste, mais aussi faux de prétendre que les pauvres sont eux-mêmes responsables de leurs malheurs.

## **1.3. Les relations population-environnement étaient autrefois indépendantes de l'activité humaine, aujourd'hui elles ne le sont plus**

Le problème démographique actuel réside dans le fait que la croissance s'est faite de façon indépendante des écosystèmes, alors que dans le passé la dépendance était très grande: une mauvaise récolte avait pour conséquence une augmentation du prix du blé, comme l'a montré par exemple pour la France du XVI<sup>e</sup> au XVIII<sup>e</sup> (Meuvret, 1965), et celle-ci était associée à des crises de mortalité. Pendant longtemps la démographie a varié en fonction des changements de l'environnement, qui lui-même commandait les ressources. Elsworth Huntington, a attribué en 1907 la migration des Mongols aux modifications du climat et, comme nous le noterons plus loin, bien des migrations commencent à être causées par des détériorations du milieu du fait des activités humaines. Les changements de climat, s'expliquaient, comme l'a encore montré Leroy Ladurie, (1967), depuis le XI<sup>e</sup>, par des facteurs non humains, alors que dans les temps modernes, ils s'expliquent essentiellement par l'activité humaine: industrialisation, déforestation, avec des conséquences qui semblent plus rapides qu'autrefois sur l'histoire de la biosphère. Nous ignorons l'aboutissement de processus que nous avons suscités et que nous ne maîtrisons pas.

#### 1.4. La dimension planétaire

Nous assistons, dit-on, à la mondialisation des problèmes fondamentaux, et notamment ceux de l'environnement. Le monde contemporain se trouve aux prises avec des défis qui ne peuvent être surmontés dans le cadre d'une nation ou d'une population particulière. On le voit bien avec les nuages transportant des pluies acides à travers les frontières, le réchauffement menaçant l'atmosphère, bien commun des riches comme des pauvres, la déchirure de la couche d'ozone, même si certains en contestent la réalité, la pollution des océans, la perte de biodiversité, etc. Nul ne peut désormais se désintéresser de ce qui se passe en dehors des frontières de son pays.

Il faudra bien un jour surmonter l'incompatibilité entre la division du monde en Etats souverains et le caractère international de décisions nécessaires à l'échelle de l'humanité.

On commence à percevoir l'interdépendance des problèmes en matière de démographie sous la forme des migrations internationales des zones les plus pauvres et les moins développées vers les plus riches. Mais autant la mondialisation des problèmes est de plus en plus acceptée pour ce qui touche à l'environnement, autant elle est refusée pour la démographie. Les pays riches continueront de se défendre contre les migrations clandestines en érigeant des barrières aux frontières, aussi peu efficaces soient-elles. Il suffit d'une infiltration faible chaque année pour créer à la longue, par un processus cumulatif, des groupes ethniques d'importance plus ou moins grande, avec les dangers de conflits internes, et par contre-coup internationaux, que cela amène tôt ou tard en l'absence d'intégration. L'histoire, et même l'actualité, fourmille d'exemples.

On peut concevoir des accords internationaux sur la protection de l'environnement, comme ce fut le cas à Rio pour les deux conventions sur la biodiversité et sur le climat, récemment aux Nations unies pour arrêter la déforestation, ou pour la protection des océans, ou celle des espèces menacées d'extinction, pour le rejet des déchets nucléaires. Certes, la volonté de faire appliquer ces conventions est mise en doute, les décideurs s'abritant derrière le principe des souverainetés nationales, par exemple pour ce qui touche à la biodiversité. Mais on n'est même jamais parvenu aux Nations unies à des objectifs chiffrés et datés sur le ralentissement de la croissance démographique, qu'il s'agisse de la première Conférence internationale sur la population de Bucarest de 1974, en dépit des efforts du Secrétariat, ou celle de Mexico de 1984. Et il y a fort à parier qu'il en sera de même de la Conférence sur la Population et le Développement du Caire, en préparation pour cette année.

L'interdépendance entre les pays en matière d'environnement est devenue telle que ceux faisant d'importants efforts de protection sont agacés par l'incurie de leurs voisins, sans pouvoir en appeler à l'opinion publique internationale. Cela peut créer à l'avenir des sources de friction entre les Etats. Le monde ne s'est pas donné une autorité en la matière. A côté de catastrophes écologiques locales ou nationales, on assiste à des problèmes d'environnement globaux. Des accords internationaux en matière d'environnement apparaîtront désormais de plus en plus indispensables.

Par contre, en matière de population, on ne peut concevoir d'accords sur la croissance des uns et des autres. Tout au plus des recommandations. Avec toutes les précautions de langage que cela requiert.

Les pays, qu'ils soient développés ou en développement, sont très soucieux sur la sauvegarde de leurs frontières. Celles-ci doivent être transmises intactes aux générations futures. Personne ne met en doute le droit à la souveraineté des Etats sur leur territoire. Le paradoxe, comme le fait remarquer Keyfitz (1989a, 1994), est que ces Etats n'hésitent pas à vendre à l'étranger des richesses qu'ils ne pourront transmettre aux prochaines générations, qui plus est, des richesses non renouvelables, comme le pétrole, les minéraux. La qualité du sol transmis pourra elle-même être dégradée à force de déboisement, de surpâturage pour produire plus de viande d'exportation, entraînant une désertification, etc. La transmission d'un environnement sain, sans gaspillage des ressources non renouvelables, devrait être un objectif aussi impérieux que la transmission de frontières intactes.

L'une des idées les plus transcendantes de ce siècle est que désormais nous avons la possibilité de rendre notre monde inhabitable, soit instantanément, par énergie nucléaire, soit par doses plus ou moins fortes mais prolongées de pollution.

Faut-il rappeler cette vérité d'évidence que c'est dans la guerre, qui tue à la fois les populations et l'environnement, que la démographie et l'écologie se rejoignent?

### **1.5. La perception des problèmes de l'environnement et de la démographie**

Comme on pouvait s'y attendre, les perceptions sur l'environnement sont vives dans les pays industriels, plus d'ailleurs dans les symptômes que dans les causes, et celles sur la démographie sont sensibles dans le Tiers monde.

Les symptômes de la détérioration de l'environnement sont perçus plus immédiatement que de ceux de l'excessive croissance démographique, moins tangibles. La pollution se voit, elle se respire. Les bébés, même lorsqu'ils sont nombreux et mal nourris, ne gênent personne, sinon les consciences.

Dans une enquête sur la perception de l'environnement faite en France en 1992 par Collomb, Guérin-Pace, et Berlan, 84 pour cent des personnes interrogées ont répondu que "l'homme a le pouvoir de perturber définitivement l'état de la nature" (1993). Et une faible minorité (10 pour cent) pense que la nature peut se rétablir d'elle-même. L'idée d'irréversibilité en matière d'environnement est donc bien ancrée dans les esprits, tout au moins dans les pays industriels qui, il est vrai, sont aussi les premiers responsables de la dégradation de l'environnement.

La perception des questions sur l'environnement dans les pays industriels est si forte qu'elle s'exprime sous la forme de partis politiques, les "verts", avec force appui médiatique. Il y a peu d'exemples équivalents dans les pays du Tiers monde.

La perception des questions de l'environnement commence cependant à être politiquement très sensible dans certains pays du Tiers monde. C'est le cas du Brésil où l'on se refuse à ce que l'opinion internationale conteste le déboisement de l'Amazonie sous le prétexte qu'une forte proportion du gaz carbonique de l'atmosphère est emmagasinée dans les forêts de l'Amazonie (Kosinski, 1991).

La perception des questions démographiques est plus discrète, mais peut aussi se manifester de façon très sensible dans les opinions publiques des pays en développement. On se souvient des événements qui ont affecté l'Inde où, au vu des résultats décevants de la politique démographique, une certaine nervosité s'était

emparée des décideurs. Ceux-ci avaient décrété en juin 1975 "l'état d'urgence" matérialisé notamment par une politique d'exhortation plus ou moins forcée à la stérilisation. La question fit l'objet d'une vive controverse dans l'opinion publique pendant la campagne électorale de 1977, et fit tomber le gouvernement de Mme Indira Gandhi. La leçon que l'on peut tirer de l'expérience indienne est qu'en régime démocratique vouloir "forcer" l'évolution de la population par des mesures coercitives, et centrer les efforts sur une seule méthode, au surplus une méthode "dure" comme l'est la stérilisation masculine, risque de créer des conditions qui se retournent contre les promoteurs de cette politique.

La question démographique peut revêtir de fortes connotations politiques. A la Conférence internationale sur la population de Bucarest de 1974, la politique démographique fut étroitement liée au "Nouvel ordre économique international" que le Tiers monde avait réussi à faire voter quelques mois auparavant par l'Assemblée générale.

On ne sait pas quel lien existe dans l'opinion publique entre les questions de la population et celles de l'environnement. La liaison commence seulement à être perçue par les écologistes eux-mêmes, comme l'a montré la Conférence de Rio sur l'environnement, alors que la Conférence de Stockholm de 1972 s'était bien gardée d'évoquer la démographie. Par contre, les Conférences sur la population de Bucarest de 1974 et de Mexico de 1984 avaient été précédées par des groupes d'experts chargés d'étudier les liaisons entre environnement et population.

A la Conférence de Rio le sujet population-environnement fut à nouveau le prétexte d'une vive controverse politique Nord-Sud. Le Tiers monde a souhaité mettre sur la sellette la consommation débridée des pays riches, et ces derniers ont tenté d'esquiver l'accusation en opposant l'excessive croissance démographique du Tiers monde. Ce fut une nouvelle façon d'éluder les problèmes, et de profiter de l'occasion pour vider d'autres contentieux. Deux ans après la conférence de Rio peu de recommandations sont suivies d'applications concrètes.

## **1.6. Conscience locale et conscience globale**

On ne sait pas non plus quel lien existe dans l'opinion publique entre les problèmes locaux de l'environnement et les planétaires, les premiers étant cependant toujours les causes des seconds. Mais toute perturbation globale se répercute localement, par un processus de va-et-vient, sur les êtres vivants et leur environnement. Autrement-dit, toute perturbation locale fait courir des dangers bien au-delà, et jusqu'au planétaire, pour retourner à l'échelle locale.

Les causes des perturbations locales, nous le verrons plus loin, sont souvent d'ordre social et politique. Ceci conduit nécessairement aux façons d'aborder concrètement ces problèmes. La formule de René Dubos (1965) "penser globalement, agir localement" devrait guider l'action tant dans le domaine de la population, que dans celui de l'environnement.

### **1.7. L'anachronique accès gratuit aux biens communs**

Bien des auteurs ont dénoncé l'anachronisme consistant à accorder un accès libre et gratuit aux biens communs que sont l'air, l'eau, comme s'ils étaient infinis et non dégradables, avec la conséquence prévisible d'un gaspillage et d'une détérioration inéluctable de ces biens communs. Les économistes commencent à reconnaître que la détérioration de ces biens communs devrait être inscrite dans les comptes économiques, au même titre que les autres biens et services. S'en tenir au PNB pour quantifier le progrès économique est une façon trompeuse de mesure de ce progrès. Ces ressources que sont les biens communs n'ont pas de valeur marchande, elles ne font pas l'objet d'appropriation. De plus, l'analyse des conséquences est difficile à faire car celles-ci sont non seulement locales mais aussi globales. Cela ne devrait pas faire obstacle au principe que "les pollueurs seront les payeurs". Parmi ces auteurs il faut citer, notamment Lee (1990), Das Gupta et Mäler (1990) et Keyfitz (1989b, 1990, 1993).

Pour Lee, une des conséquences les plus notables de la pression excessive de la population porte sur les ressources de l'environnement. Une gestion optimale de ces ressources devrait inclure une politique optimale de population.

### **1.8. Conscience macro et conscience micro. Le faux ou le vrai dilemme entre développement et environnement**

On dit parfois que le coût de la préservation et de l'entretien de l'environnement compromet les chances de développement du Tiers monde, car il viendrait s'ajouter au coût des projets de développement, et que certains projets de développement peuvent contrevenir à une saine gestion de l'environnement. Il y aurait une incompatibilité entre la protection de l'environnement et l'amélioration du bien-être et de la santé de la population.

Apparemment les réponses à ces questions ne sont ni claires, ni univoques. Certes, chacun convient que non seulement il n'y aurait pas de conflit entre développement et préservation de l'environnement, mais qu'il ne pourrait y avoir de développement durable sans préservation et entretien de l'environnement.

Mais ce qui dans l'immédiat peut paraître prioritaire pour les uns peut ne pas l'être pour d'autres. Pour bien des pays du Tiers monde la priorité est le développement, comme ce fut le cas pour les pays industriels à leur époque de plein développement sans considération pour l'environnement. Il est vrai que ce souci n'a émergé dans la conscience collective qu'à partir des années 60. Le Brésil souhaite coloniser les terres amazoniennes car celles-ci sont indispensables à son développement, quels que soient les points de vue d'autres pays pour qui les forêts et la biomasse de la région recèlent un quart de tout le gaz carbonique de la planète. L'Amazonie serait aussi le réservoir biogénétique le plus vaste de la planète. Les intérêts nationaux et mondiaux ne s'accordent pas nécessairement.

Les problèmes globaux de l'environnement ou de la démographie sont perçus différemment par les pays industriels et par le Tiers monde.

Ce serait trop demander au Tiers monde de freiner son développement jusqu'à ce que le Nord trouve des substituts "propres" et bon marché à l'énergie fossile (Sachs, 1992).

Certains pays du Tiers monde se plaignent que les précautions à apporter à l'environnement exigées par des bailleurs de fonds internationaux pour certains projets peuvent rendre ces projets irréalisables.

Il est certain que les questions de l'environnement, lorsqu'elles dépassent l'aire locale, comme par exemple celles touchant à un possible réchauffement de la terre, ou à la déchirure de la couche d'ozone, peuvent paraître abstraites et étrangères au petit paysan ou à l'habitant pauvre du Tiers monde. Il y a conflit entre une conscience à l'échelle macro et une conscience à l'échelle micro des questions de l'environnement. L'on ne pourra sortir de ce conflit tant que l'on n'aura pas lutté efficacement contre la pauvreté.

### **1.9. Les phénomènes "pervers", les externalités**

En fait, on se trouve en présence avec les détériorations de l'environnement, de phénomènes "pervers", comme disent les sociologues (Boudon, 1977), en ce sens que c'est l'agrégation d'actes individuels qui provoque des résultats que personne ne voulait, ou en présence d'externalités, comme disent les économistes. Les individus sont à la fois libres et conscients de leurs actes individuels, mais souvent inconscients des effets collectifs que provoque leur agrégation. Mais si le sens d'une responsabilité collective commence à émerger pour ce qui touche à l'environnement, cette responsabilité est encore totalement absente pour ce qui touche à la démographie. Or, en démographie aussi, on peut parler d'externalité. Une forte fécondité des uns affecte les conditions d'autres moins prolifiques. On le voit bien en ce qui concerne les retraites par exemple, puisque les droits à la retraite ne tiennent pas compte des fécondités individuelles.

### **1.10. L'impossible continuation et généralisation du mode de vie occidental. Discrimination à l'encontre des pauvres?**

On est bien obligé de remarquer que le monde est toujours embrayé sur la croissance démographique et sur celle de la production. Le monde est resté sourd aux appels d'une remise en question complète des choix de développement et de consommation des pays riches, il y a déjà 25 ans, même si l'argumentation fut souvent récusée, tels ceux: de Sicco Mansholt, alors président de la CEE, dans une lettre fameuse incitant les pays riches à une croissance économique nulle; des Meadows et du Club de Rome (1972); des Ehrlich (1990); des alertes répétées de l'agronome René Dumont auteur de nombreux ouvrages, et notamment il y a une trentaine d'années "L'Afrique est mal partie" (Dumont, 1962); des oeuvres d'un des économistes les plus respectés de l'époque (Myrdal, 1968), qui a exhorté les pays riches à déclarer un moratoire sur leur croissance. Plus récemment les rapports nombreux de la Banque mondiale (1984); le rapport Global 2000 au président des Etats Unis (1980); le rapport commun de la Royal Society of London et la U. S. National Academy of Sciences des Etats Unis en 1992; les nombreux écrits de Keyfitz, démographe de renom (1990, 1991a, 1991b, 1993); les appels répétés de Lévi-Strauss pour qui "ce fut un luxe insoupçonné pour

l'humanité, et une chance pour toutes les formes de vie, quand deux ou trois milliards seulement d'individus habitaient la planète" (1991). Face à ces déclarations de hautes personnalités et institutions il faut reconnaître que l'on trouve moins de points de vue opposés. On doit noter l'attitude de Sauvy (1949), dont l'audience fut considérable, qui combattit longtemps le concept même de population mondiale, les écrits récents de Commoner (1990, 1991, 1992), pour qui la responsabilité de la démographie dans la détérioration de l'environnement est exagérée, et de Simon (1981) résolument opposé à toute attitude malthusienne.

Aucun auteur sérieux n'a jamais pensé, à moins d'aveuglement volontaire, ou d'ignorance improbable, que l'espèce humaine continuerait de se multiplier comme elle l'a fait au cours des cinquante dernières années, et que le taux de croissance de la production observée de 1945 à 1965 se prêtait à une extrapolation indéfinie.

De fait, les problèmes vitaux sont tous des problèmes d'équilibre. Il suffit de regarder autour de soi. Dans tous les systèmes vitaux et les cycles, dans le corps humain, dans les océans, les forêts, dans les espèces rien, jamais ne croît indéfiniment sans qu'émerge un phénomène d'autorégulation spontané d'adaptation et d'ajustement des écosystèmes. Il n'y a pas de raison de penser qu'un nouvel équilibre ne sera pas atteint, mais dans les circonstances actuelles on ne voit pas comment cet équilibre se formera si une prise de conscience des problèmes n'est pas suivie d'une action efficace pour enrayer une évolution que chacun redoute.

La dure réalité est que la généralisation du type de développement des pays riches dans le Tiers monde est une éventualité qui s'éloigne de plus en plus de l'horizon, quelles que soient les perspectives optimistes des successives "Décennies du développement" des Nations unies. Il est inconcevable que dans la période où nous entrons l'égalité puisse s'établir au plus haut, puisque si elle est combinée à l'accroissement démographique, dont nous discutons plus loin les perspectives des Nations unies, elle conduirait à une augmentation par cinquante ou soixante de la consommation, avec tout ce que cela implique pour l'environnement. Un demi milliard d'automobiles sont actuellement enregistrées dans le monde, principales causes de l'effet de serre. Imagine-t-on ce qu'il en serait avec plusieurs milliards de véhicules circulant sur les routes et les villes dans les deux hémisphères pour satisfaire les aspirations de tous? Le confort occidental ne peut être généralisé rapidement sans graves atteintes à l'environnement. Il doit être considéré comme un épisode très bref de l'histoire du monde. Il doit laisser la place à des formes de vie plus frugales, et même plus austères. Une croissance économique "allégée" et une démographie stabilisée des pays riches pendant plusieurs décennies, associée à une croissance démographique ralentie du Tiers monde, sont des conditions indispensables à la transmission d'un héritage que les générations précédentes nous ont elles-mêmes légué.

### **1.11. La perte de biodiversité**

Les biologistes et les entomologistes nous assurent que chaque année des centaines, voire des milliers, d'espèces animales disparaissent du fait de la déforestation, de la pollution des océans, des changements dans les pratiques agricoles, de l'urbanisation accélérée. Les agronomes nous disent que la même perte de diversité est observée

dans le monde végétal du fait des monocultures en remplacement des cultures vivrières, des engrais chimiques et pesticides. On compterait 1,4 million (Sioli, 1985) à 1,7 million d'espèces décrites à ce jour (Chauvet et Olivier, 1993) sur un total estimé entre 10 et 30 millions. Les pays du sud sont détenteurs de la majeure partie des ressources biologiques. Ils ont donc un rôle considérable à jouer dans la protection de ces ressources.

On ne peut qu'éprouver un sentiment d'angoisse devant tout ce qui menace la survie, le maintien de la diversité du monde animal ou des plantes. Il est exclu qu'une espèce animale ou végétale disparue, synthèse complexe et unique, puisse être remplacée par une espèce équivalente, et nous agissons à leur égard avec la même désinvolture que pour la consommation de matières minérales non renouvelables, dont la formation et la concentration se sont poursuivies pendant plusieurs ères géologiques. Pour ne citer qu'un exemple, ayant valeur de symbole, on dit que la population des pandas en Chine au cours des quatre dernières décennies s'est réduite à quelques milliers d'animaux perdant graduellement leur couleur blanche, alors qu'elle a été florissante pendant des milliers d'années. Elle est décimée par le manque de bambous qui constituent l'essentiel de leur nourriture, alors que la population humaine en doublant pendant la même période a remplacé les terres de bambous par des cultures propres à sa propre nourriture. Et que dire de l'extinction progressive des grandes baleines bleues, et de bien d'autres vies animales, moins visibles, mais peut-être plus vitales pour la survie de notre planète. Nous ne cessons de casser des chaînes de complémentarité qui font la force des écosystèmes.

Il faut reconnaître que nous n'avons encore qu'une faible compréhension des interactions entre les systèmes biologiques et les agents chimiques et physiques.

La démographie aurait une part de responsabilité dans ces phénomènes, et nous discuterons ce point plus loin dans ce rapport.

### **1.12. L'interdépendance entre les écosystèmes**

La crise est salutaire car elle a révélé que l'on avait négligé les lois gérant les écosystèmes (Morin, 1978). D'une part, la biosphère est un contenu vivant à la fois très robuste et très fragile fait d'intégrations éco-organisatrices entre unicellulaires, végétaux, animaux, humains, et l'ensemble des conditions géophysiques, pouvant être gravement endommagé si on lui injecte trop de poisons qui dégradent sans être eux-mêmes dégradés. D'autre part, comme tous les êtres vivants, l'homme est un système "ouvert" dépendant des autres écosystèmes.

### **1.13. Le progrès des connaissances**

Dans le domaine complexe des relations population-environnement notre connaissance est très fragmentée. Et cependant, elle appelle une démarche et des réponses distinctes des problèmes anciens. Que sait-on au juste, que ne sait-on pas et que devrions-nous savoir?

L'analyse des problèmes population-environnement est tributaire au premier chef des données sur chacun des deux éléments.

La population se présente sous trois aspects: volume, croissance et migrations. L'environnement se présente, lui, sous une myriade de facteurs: air, eau, terre, monde végétal et animal, et chacun de ces facteurs se décompose en une série d'éléments. En fait, on ne connaît pas très bien les frontières de l'environnement. Comme écrivent Teitelbaum et Winter (1993), le terme "environnement" est vague et ambigu. Il ne faut pas s'étonner si nous disposons de données plus abondantes et plus sûres sur la population que sur l'environnement. Il est vrai que la recherche démographique a une histoire plus longue que celle sur l'environnement. L'Essai de Malthus fut publié il y a presque deux siècles (1796), alors que le terme écologie, dû au biologiste allemand Haekel, n'est apparu qu'en 1906, et la recherche dans ce domaine est encore très récente.

L'examen de la littérature montre que celle-ci a fait récemment des progrès considérables pour s'adapter aux observations nouvelles. Pendant longtemps cette littérature était restée théorique, abstraite, s'exprimant en controverses plus ou moins stériles entre malthusianistes et populationnistes, basées souvent sur des modèles théoriques (Coale-Hoover, Domar, Bachue, etc) peu opérationnels, visant parfois les seuls aspects globaux de l'environnement, sans référence aux conséquences sur la biosphère. Au cours de ces dernières années, et notamment à l'occasion de la préparation de la Conférence sur l'Environnement et le Développement de Rio de Janeiro (juillet 1992), les recherches sont devenues plus concrètes, basées souvent sur des observations et analyses à l'échelle locale. Deux ouvrages, l'un dû à Norman Myers (1992), l'autre dû à Mary Barbies (1993) ont donné des vues d'ensemble intéressantes de la littérature. Il faut ajouter les travaux scientifiques de synthèse de la Division de la population des Nations unies, notamment ceux d'un groupe d'experts en vue de la préparation de la conférence mondiale sur la population (UN, 1992), les publications du FNUAP (1992). Ceux, enfin, de la commission dite Commission Brundtland qui fait autorité en plaçant les problèmes dans le cadre du développement.

#### **1.14. La Commission Brundtland**

La commission Brundtland, du nom de son président, Mme Gro Brundtland, premier ministre de Norvège, a été établie par l'Assemblée générale des Nations unies de 1987 sous le nom de Commission sur l'Environnement et le Développement.

La Commission a défini ce que désormais on appelle le "développement durable", c'est-à-dire la capacité de gérer l'interaction entre les activités humaines et l'environnement physique et biologique, afin de préserver et promouvoir la qualité de la vie des générations actuelles et futures, sans menacer l'intégrité des écosystèmes naturels dont dépendent toutes les formes de vie. L'idée majeure est que l'accélération des progrès et des techniques dans les pays riches, et plus généralement des atteintes à l'environnement, qu'elles viennent des pays riches ou des pays pauvres, risquent de provoquer des chocs en retour. Il faut s'attacher, certes, à la solution des problèmes actuels, mais sans pour autant faire confiance aux ressources illimitées de la technique pour résoudre plus tard ceux qui se dessinent à l'horizon, mis en quelque sorte en réserve, jusqu'à ce qu'ils se présentent à leur tour aux générations futures qui seraient "prises de court" inéluctablement. Ces idées étaient déjà en germe dans un ouvrage célèbre de Barbara Ward et René Dubos *Only One Earth* (1972), en vue de la Conférence mondiale sur l'environnement de Stockholm de 1972. Le titre de la

publication des travaux de la Commission *Our Common Future* est lui-même voisin de celui de Ward et Dubos.

La Commission a souligné le fait que les problèmes de l'environnement sont directement liés à ceux de la démographie, de la pauvreté et du statut de la femme, affirmant l'existence de liens de causalité entre ces facteurs. Elle a souligné, ce que nous avons antérieurement discuté, le caractère international des problèmes posés. Le concept du principe de la souveraineté nationale est remis en question par les réalités de l'interdépendance écologique et économique.

## **2. La part de la démographie dans la détérioration de l'environnement**

Il faut commencer par rappeler que les travaux sérieux, s'ils attribuent une responsabilité variable à la démographie dans la détérioration de l'environnement, s'accordent cependant à dire qu'il existe un faisceau complexe de facteurs responsables, dont la logique interne échappe à l'analyste. Nombre de ces facteurs sont d'ordre économique, social, politique, autant que démographique, sans qu'il soit possible d'établir une hiérarchie entre eux.

On peut d'ailleurs citer des dégradations n'ayant rien à voir avec la démographie, comme les désastres naturels, la décharge de déchets nucléaires dans les océans. Si un gouvernement stimule la vente de bois à destination commerciale, ou pour l'exportation, cela peut avoir des conséquences sur l'environnement, mais la cause n'en est pas démographique. C'est notamment le cas de l'Indonésie, et même dans une certaine mesure de l'Amazonie brésilienne pour la construction d'hébergements des colons, ou de la région du Sahel, comme le font observer Repetto et Holmes (1993). L'agriculture intensive, fondée sur l'usage intensif de la chimie épuisant la fertilité des sols, en vue de la commercialisation des récoltes, n'a également rien à voir avec la démographie.

La tendance est aussi souvent à dramatiser des situations au demeurant dégradées. C'est ainsi qu'un rapport de 1978 d'une institution internationale, qui à l'époque eut un grand retentissement, estimait que si le taux de déboisement des contreforts du Népal devait continuer au même rythme, la région serait totalement déboisée en 15 ans, ce qui, bien entendu, n'est pas observé. En fait, une étude du gouvernement a montré que le taux de déboisement était exagéré. Il y a un risque de tout réduire au problème strictement démographique, ou strictement écologique, ou même strictement économique, social, politique, alors que les facteurs en jeu sont toujours nombreux et interconnectés.

Cependant, le déboisement de bien des pays du Tiers monde est incontestable. Seule son étendue est discutée. Pendant longtemps la forêt tropicale était considérée comme n'ayant aucune valeur économique, et que de nombreux profits pouvaient être tirés de son déboisement, puis de son remplacement par des cultures, pour nourrir des populations croissantes.

Donnons quelques exemples de déboisement. La forêt aurait disparu dans la proportion de 43 pour cent au Guatemala, de 74 pour cent au Soudan (Bilsborrow and Delargy, 1990). Selon Dennis Mahar, cité par Foyet et Daly (1992), la zone déboisée

de l'Amazonie indienne serait passée de 125 000km<sup>2</sup> en 1980 à 600 000km<sup>2</sup> en 1988. Barberis (1993) a réuni une impressionnante documentation sur le déboisement en Inde, en Indonésie, au Népal, aux Philippines, en Thaïlande. Dans ce dernier pays la forêt couvrait 55 pour cent des superficies en 1961, et seulement 28 pour cent en 1989. Myers (1989, 1990) a également donné de nombreuses estimations du taux de déboisement dans le monde. Toutes les estimations recueillies et les analyses tendent à montrer que la croissance démographique et la transformation de la forêt en terres cultivées ont eu pour conséquence un appauvrissement des sols. Allen et Barnes (1985), en se fondant sur des données de la FAO pour nombre de pays du Tiers monde, ont confirmé cette conclusion au moyen d'une analyse statistique. C'est au Salvador que la déforestation et l'érosion des sols ont été les plus poussées, passant de 90 pour cent à 3 pour cent des superficies, au point que 90 pour cent du bois est maintenant importé (Bilsborrow, 1992). Selon la FAO (1986) et la Banque mondiale (Mink, 1993) la destruction de forêts, estimée par images satellitaires, atteindrait de 17 à 20 millions d'hectares par an, dont environ la moitié en Amérique latine, et le taux de déforestation dans le Tiers monde serait de l'ordre de 1 à 1.5 pour cent par an. Il ne s'agit que d'une moyenne, et l'on cite des taux dépassant 10 pour cent au Nigéria et en Côte d'Ivoire.

S'il n'existe aucune certitude sur la part de chacun des facteurs en cause sur la dégradation de l'environnement, cela peut à l'évidence inhiber l'action. Cependant, bien des experts répondent: "si nous attendons d'avoir des certitudes, l'accumulation rendra le traitement du phénomène quasi impossible, en tout cas ne fera que rendre celui-ci plus coûteux". C'est un peu le pari de Pascal. Traiter les causes des détériorations de l'environnement ne peut que présenter des avantages, quelles que soient les parts de chacune d'elles.

## **2.1. Les deux sources de la détérioration de l'environnement: richesse et pauvreté**

On s'accorde à dire que la détérioration de l'environnement est le fait, d'une part, des populations riches, ou qui tendent à le devenir, notamment par la production et la consommation de produits industriels et, d'autre part, de la pauvreté.

Pour ce qui est des pays riches une abondante documentation sur la consommation de matières premières et sur la pollution entraînée par l'industrialisation, et par la modernisation de l'agriculture, montrent à l'évidence une responsabilité de ces pays dépassant de loin celle du Tiers monde dans la détérioration de l'environnement. Citons quelques chiffres ayant valeur synthétique, ceux de la Commission Intergouvernementale sur le Changement de Climat (Intergovernmental Panel on Climate Change, IPCC). Les émissions de gaz carbonique dans le monde en 1985 auraient été de 5.15 milliards de tonnes, dont 3.83 par les pays développés et 1.33 par les pays en développement. Par tête les chiffres seraient de 3.83 tonnes par habitant de pays développé et 0.36 par habitant du Tiers monde (IPCC, 1991). Nous reviendrons plus en détail sur ces chiffres.

Pour ce qui concerne le Tiers monde, la majorité des auteurs, notamment Bilsborrow (1992) et Martine (1993a, 1993b), montrent que l'augmentation des bouches à nourrir et la pauvreté poussent souvent les paysans à cultiver plus intensément des terres

marginales, à déboiser, à diminuer les périodes de jachère, à faire du surpaturage, à répéter les cultures sur brûlis, contribuant ainsi à l'appauvrissement des sols.

La forte croissance démographique peut entraîner une augmentation de la demande alimentaire avec plusieurs sortes de conséquences:

- Déboisement de terres converties à l'agriculture pour nourrir une population croissante avec tout ce que cela peut impliquer pour l'environnement: perte de matières organiques sur les terrains défrichés, appauvrissement de la biodiversité, intensification de l'érosion, finalement diminution de la fertilité des sols. Le déboisement peut raréfier l'offre de bois, et augmenter son prix, si bien que par un cercle vicieux le déboisement se trouve accéléré.
- Usage plus intensif des terres déjà consacrées à l'agriculture au moyen de fertilisants chimiques et de pesticides, et expansion de l'agriculture vers des terres marginales pauvres ou déboisées, ou dont la productivité est artificiellement rehaussée au moyen également d'engrais chimiques et pesticides.
- Utilisation plus intensive des terres de petits fermiers pauvres et chargés de famille, amenés pour leur survie aux pratiques que nous venons de décrire. Cela fait partie de ce que Bilsborrow (1987) appelle une "stratégie de survie du ménage" ("household survival strategy").
- Conversion de forêts tropicales en pâturage pour la production de viande.
- Migration de fermiers vers de nouvelles terres, ou des terres marginales, ou non consacrées jusque là à l'agriculture. La migration peut aussi être le fait des enfants du fermier dont les terres ne peuvent suffire à un partage entre tous les enfants survivants, et dont le nombre a pu augmenter en raison de la baisse de la mortalité. Certes, la migration est souvent une façon efficace de soulager la pression démographique dans certaines terres, ou pour pallier la mauvaise distribution des terres fertiles, mais bien des auteurs ont montré combien la migration d'aires rurales vers d'autres aires rurales a pour conséquence un déboisement de terres nouvelles ou marginales.
- Eviction de terres exploitées par des populations autochtones par les migrants colonisant les "nouvelles" terres, ou par les grands propriétaires.
- Concentration des propriétés, les petits fermiers étant conduits du fait de leur pauvreté, et de leur charge de famille, ou parce que ne pouvant supporter la concurrence avec les grandes propriétés, à vendre leur lopin de terre à de riches fermiers, ce qui aurait pour conséquence d'augmenter la concentration des propriétés. Et l'on sait que les grands propriétaires à la recherche de profits maximum utilisent des méthodes culturales intensives et dommageables à l'environnement. Les lois du marché sont souvent plus responsables de la concentration des propriétés que les facteurs démographiques, ou s'ajoutent à ces derniers.
- Excès de pêche dans des eaux qui peuvent devenir polluées par les décharges industrielles ou autres.

Derrière les facteurs démographiques se profilent d'autres facteurs moins apparents, ayant une incidence indirecte, mais pouvant avoir un impact considérable sur l'environnement. Ces facteurs peuvent être d'ordre économique, social, politique. Ce sont les facteurs "sociaux inhérents" ("socially constructed") (Bilsborrow, 1992).

Parmi ces facteurs on doit citer le coût élevé de l'énergie incitant la population à déboiser pour obtenir du bois de chauffe, l'absence de réforme agraire, l'incitation des gouvernements à la colonisation de nouvelles terres, l'insuffisance du titre de propriété des petits fermiers dont la situation juridique devient précaire, les subventions des gouvernements à l'exportation de bois, les incitations des autorités au remplacement des cultures vivrières par des cultures destinées à l'exportation, notamment de viande, les mécanismes du marché.

Prenons l'exemple souvent cité de l'Amazonie brésilienne. On y trouve une conjonction de tous les facteurs cités, démographiques ou "socially constructed": la forte croissance démographique du Nord-Est, et la croissance désordonnée de villes géantes d'où émanent nombre d'immigrants, ainsi que l'insuffisance des services de planning familial dans ces zones. Ces facteurs sont les causes primaires de l'immigration dans cette partie de l'Amazonie et de la détérioration de son environnement. Cependant, d'autres facteurs ont joué de façon indirecte: la pauvreté car le déboisement constitue l'opportunité la plus attirante pour les nouveaux venus dans la force de travail, ne requérant aucun capital et aucune qualification particulière; l'insuffisante réforme agraire dans le Nord-Est et le Sud-Est du pays; les incitations du gouvernement à l'émigration des populations du Nord-Est et à la colonisation de l'Amazonie; les déplacements massifs facilités par l'aménagement du réseau routier (Trans-Amazonia Highway); les subventions à l'exportation de bois exotiques ou de bois de construction, encourageant ainsi le déboisement; l'expansion des cultures extensives et la réorganisation des systèmes de production agricole; l'inégalité sociale poussant les petits fermiers à exploiter des terres marginales pour leur survie quels qu'en soient les dommages à l'environnement. Aucun de ces facteurs ne peut à lui seul expliquer la détérioration de l'environnement dans ces zones.

De nombreuses études corroborent ces analyses, telles celles de Bilsborrow et Delargy (1990) pour le Guatemala et le Soudan, de Stonich (1989) pour l'Amérique centrale, Barberis (1993) pour Java, Cruz *et al.* (1992) pour les Philippines et Costa Rica, Panayotou (1989) pour la Thaïlande, et de façon générale les synthèses de Barberis (1993), les nombreux rapports de la FAO et de la Banque mondiale.

Bilsborrow et Geores (1991), dans une analyse statistique portant sur 85 pays en développement, ont obtenu une corrélation élevée et significative entre le taux de déboisement et le taux d'accroissement de la population rurale de ces pays.

Pour ce qui concerne l'Afrique sub-saharienne, les habitants y vivent dans un environnement difficile, et qui s'est dégradé au cours des dernières décennies au point que la région arrive de moins en moins à couvrir ses besoins alimentaires. Si l'on exclut les aires désertiques, les zones sèches couvrent 43 pour cent des superficies où vivent 66 pour cent de la population. La désertification de l'Afrique, dont l'étendue est hautement contestée et le mécanisme encore peu compris, est imputée par presque tous les auteurs, et comme pour les autres régions du Tiers monde, à un faisceau de facteurs: certains structurels, liés au développement social et économique, climat, activité humaine, conflits ethniques, croissance démographique des humains et des animaux. On ne sait pas si la désertification, phénomène certain, mais complexe, et dont l'ampleur est mal estimée, est réversible. Selon la FAO (1992) la désertification serait un aspect d'une détérioration générale des écosystèmes sous l'effet combiné de facteurs climatiques et de changements dans les pratiques agricoles.

## 2.2. L'effet de l'environnement sur la démographie

On peut distinguer trois effets de l'environnement sur la démographie: les catastrophes naturelles, la santé et la migration.

### Les catastrophes naturelles

Il peut paraître banal de dire que l'une des sources les plus fortes d'iniquité réside dans la qualité de l'environnement "naturel" et dans la base des ressources du pays dans lequel chacun est né, ou dans lequel il réside. Dans la plus grande partie de l'hémisphère Nord, et notamment en Europe, l'environnement "naturel" est relativement favorable, alors qu'il est souvent préjudiciable à la santé, et plus généralement à la qualité de la vie, dans l'hémisphère Sud où les conditions climatiques sont dures et les terres moins fertiles, particulièrement dans les tropiques. On pourrait presque ajouter que l'environnement est dans l'hémisphère Sud un obstacle au bien-être des populations et au développement économique. Le Tiers monde est, d'ailleurs, bien mal armé pour affronter les calamités naturelles, ou autres, qu'il s'agisse des séismes ou d'inondations ou d'accidents industriels graves comme celui de Bhopal en Inde.

De plus, c'est dans l'hémisphère Sud que la croissance démographique est la plus rapide, la distribution géographique des populations la plus déséquilibrée avec des villes gigantesques, et pour lesquelles les projections des Nations Unies (1993) prévoient une croissance encore plus forte à l'avenir en raison, soit de l'accroissement naturel, soit du fort potentiel d'immigration des milieux ruraux.

Redresser les "iniquités naturelles" créées par l'environnement serait une tâche redoutable. Ce devrait être un des thèmes de coopération entre pays inégalement traités par l'environnement. Protéger Hanoï contre les inondations est concevable, mais protéger le Bangladesh pris entre les inondations de l'Océan indien au sud et du Gange à l'intérieur est une oeuvre de Titan. Il est cependant des travaux dont le coût-bénéfice peut paraître à la portée de la communauté internationale. Donnons l'exemple des populations souffrant de déficit en iode. Selon l'OMS (1990) des centaines de millions d'habitants sont atteints de cette déficience, essentiellement dans des pays en développement, par manque de ce minéral dans les plantes sur des sols pauvres en iode. Cependant des solutions simples et peu coûteuses, sont envisageables: iodisation du sel ou dans les puits (OMS, 1988; Fisch et al. 1993). Aucune mesure n'a encore été prise à l'échelle nationale ou internationale.

De nombreuses autres sources "d'iniquité naturelle" peuvent être citées, comme les habitats dans des aires présentant des risques écologiques (aires menacées d'inondation, de glissement de terrain, de tremblement de terre, désertification), parce que ces aires sont impropres à un habitat sain, ou parce que la surpopulation et la pauvreté ne laissent aucun autre choix. Nous avons tous à l'esprit le récent tremblement de terre (octobre 1993) qui a frappé l'ouest de l'Inde et fit des milliers de morts et des destructions considérables. A peu près au même moment (janvier 1994) un tremblement de terre à Los Angeles de même intensité (5.8 dans l'échelle de Richter) fit une soixantaine de morts et moins de familles sans abri.

## La santé

Les altérations de santé sont parmi les plus importantes conséquences démographiques de la qualité de l'environnement ou des changements de l'environnement. De fait, la première, et la plus grande, lutte des humains contre l'environnement, a été une pollution biologique aux effets meurtriers et facilement discernables: les grandes épidémies, dont il fallut attendre l'ère pasteurienne pour en saisir les causes et trouver des moyens efficaces d'action.

L'un des dangers les plus menaçants pour la santé est la rareté grandissante de l'eau due, en grande partie à la croissance démographique, et sa contamination. L'eau est délicate, si délicate qu'elle est tombée elle-même malade à force d'absorber du phosphore, de l'azote, du mercure, de l'arsenic, du plomb. Elle peut être extrêmement dangereuse si elle n'est pas convenablement traitée, ce qui suppose d'importants moyens économiques. On se souvient de l'état d'une population japonaise gravement atteinte à Minamata en 1968 par de l'eau contaminée d'oxyde de mercure. Des maladies qu'on croyait vaincues par l'amélioration des systèmes d'approvisionnement en eau ont fait récemment leur réapparition, comme l'épidémie de choléra qui a touché de nombreux pays latino-américains en 1991.

Le Groupe d'Experts des Nations unies sur la Population, l'Environnement et le Développement (United Nations, 1992), a estimé que 88 pays en développement, soit 40 pour cent de la population mondiale, tous avec des taux de croissance démographique comprises entre 2.5 et 3.8 pour cent par an, souffraient de rareté de l'eau. Mais il est bien évident que si le facteur démographique joue un rôle important, l'absence de développement joue également un rôle, au moins pour la qualité de l'eau. On pourra se reporter sur l'importante question de l'eau aux travaux de Falkenmark (1989a, 1989b).

L'OMS (1992) a publié un important rapport sur la santé et l'environnement en vue de la préparation de la Conférence de Rio de Janeiro sur l'environnement. Cette fois il ne s'agit pas de catastrophes naturelles inévitables, mais du fait que des millions de personnes perdent la vie ou la santé à cause de maladies pourtant évitables que provoque le milieu dans lequel elles vivent: pollution de l'air dans les logements ou à l'extérieur, causée par l'utilisation de combustibles de la biomasse et d'autres formes d'énergie, pollution atmosphérique dans les villes où s'est développée l'industrie, décès de 4 millions de nourrissons et d'enfants en bas âge dus chaque année à des maladies diarrhéiques, transmises par l'eau ou la nourriture contaminée, décès de plus d'un million de personnes annuellement causés par le paludisme, et infections nouvelles de 276 millions de personnes, etc. Les conditions de travail sont également responsables de maladies respiratoires, mais pour lesquelles le facteur démographique est peu responsable. L'OMS (1993) a récemment publié une *Stratégie mondiale OMS pour la Santé et l'Environnement* conçue essentiellement dans un esprit de prévention.

## Les migrations

On observe de plus en plus des mouvements de population dus aux changements de l'environnement. Il existe de nombreux exemples de "réfugiés dus à l'environnement" ("environmental refugees"), notamment dans des zones tropicales affectées par une

très haute croissance démographique, la sécheresse, le déficit en eau, ou la diminution de la fertilité des sols entraînée par la déforestation, l'épuisement des sols et, de façon générale dans toute aire qualifiée "d'écologiquement instable". Les perspectives paraissent inquiétantes avec la possibilité d'un réchauffement du climat, la montée du niveau de la mer pour les millions de personnes vivant près des côtes. Et l'on sait que 60 pour cent de la population mondiale vit à moins de 80 kilomètres des côtes.

### **3. L'avenir de la population mondiale et ses conséquences sur l'environnement**

#### **3.1. Les projections démographiques des Nations unies**

La croissance démographique est bien mesurée à peu près partout dans le monde, et des projections à très long terme sont périodiquement effectuées par les Nations unies et par la Banque mondiale. Les derniers calculs des Nations unies portent sur une très longue durée puisqu'ils vont pour la première fois jusqu'en 2150 par grandes régions (Grinblat, 1993). L'hypothèse fondamentale est que les populations tendent l'une après l'autre vers une situation stationnaire, hypothèse commode, commune à toutes les populations, mais qui ne repose sur aucun argument théorique, ou même historique. C'est cependant la seule que l'on puisse retenir actuellement. Pour la première fois aussi 7 variantes sont distinguées, allant d'une fécondité basse à une fécondité constante. Les résultats sont donc très ouverts, allant de 5,3 milliards d'habitants en 1990, à 694,2 milliards en 2150 dans la variante "fécondité constante" et à 4,3 milliards dans la variante "basse" qui suppose donc des baisses substantielles de fécondité.

#### **3.2. La plausibilité des hypothèses**

Ces deux variantes étant de toute évidence aussi peu crédibles l'une que l'autre, intéressons-nous plutôt aux deux variantes intermédiaires "moyenne" et "moyenne haute". La première donne 11,5 milliards en 2150, et la seconde 20,8 milliards. Et, cependant, les deux variantes diffèrent assez peu dans les hypothèses d'évolution de la fécondité: de l'ordre de 7 pour cent en 1990-95, pour monter jusqu'à 21 pour cent en 2025-30, et redescendre jusqu'à 5 pour cent de 2100 à 2150. En moyenne, la différence de fécondité est de 10 pour cent. On n'est guère surpris qu'un écart de cette ampleur conduise à des résultats si divergents puisque la durée de la projection est très longue. Mais cela montre une fois de plus l'extrême sensibilité de l'évolution démographique future aux changements de fécondité, et l'importance qu'il faut attacher aux succès, ou aux échecs, des programmes de planification des naissances, si l'on souhaite qu'une variante plutôt qu'une autre se rapproche de la réalité future. Bien entendu, nous ne saurions attribuer les changements de fécondité exclusivement aux politiques de planification familiale, mais celles-ci jouent un rôle important, voire décisif, dans le Tiers monde.

On peut concevoir que la croissance démographique soit gérable dans le cas de la variante "moyenne" si des mesures d'accompagnement sont prises suffisamment à temps sur le développement, l'entretien de l'environnement, la conservation des

ressources. Après tout, un doublement en 150 ans est un accroissement semblable à celui que le monde a connu en seulement 42 ans entre 1950 (2,5 milliards d'habitants) et 1992 (5,4 milliards), il est vrai à une époque où le taux de croissance de la population était parvenu à des sommets (2 pour cent) qu'on ne reverra sans doute jamais à l'échelle des générations actuelles, ou même prochaines. D'aucuns peuvent légitimement douter du bien fondé de l'assertion selon laquelle la croissance démographique supposée dans cette variante serait gérable, puisqu'au cours de ces 42 années l'environnement s'est déjà notablement détérioré, et la variante "moyenne", si mesurée soit-elle, peut paraître constituer elle-même un obstacle au progrès économique et social, et à un environnement sain.

Par contre, on peut se risquer à dire que la variante "moyenne haute", qui verrait à peu près un quadruplement de la population entre 1990 (5,4 milliards) et 2150 (20,8 milliards) créerait une situation intolérable avant le terme de la projection.

Le choix des hypothèses qui préside aux variantes est hautement spéculatif. Mais si l'on se réfère à la baisse continue de la fécondité des pays industriels au cours de ces trente dernières années on a toutes raisons de penser que pour ces pays la variante "moyenne haute", qui amènerait la population de ces pays à doubler entre 1990 et 2150, passant de 1090 à 2156 millions, serait assez peu plausible. L'avenir démographique des pays industriels est très difficile à projeter, mais il semble plus vraisemblable de s'en tenir à une variante "moyenne" qu'à une variante "moyenne haute". Au surplus, on imagine aisément la réaction des écologistes et de tous ceux qu'inquiète l'inégalité des conditions de vie dans le monde devant la perspective de voir doubler les habitants des pays riches qui consomment infiniment plus de ressources naturelles et qui polluent cinq fois plus l'environnement que les pays actuellement en développement.

Par contre, pour les pays en développement il convient de retenir les deux variantes "moyenne" et "moyenne haute" qui, en fait, comme nous l'avons dit, ne diffèrent que peu dans l'évolution de la fécondité, avec les distinctions qui suivent.

La population de l'Afrique, estimée à 642 millions en 1990, passerait à 2265 millions en 2050 et à 3090 millions en 2150, selon la variante "moyenne", et à 5640 millions en 2150 selon la variante "moyenne haute", soit une multiplication par 3, 5 d'ici à 2050 et 4, 8 d'ici à 2150 selon la variante "moyenne", et 8, 8 d'ici à 2150 selon la variante "moyenne haute". La densité moyenne actuellement de 25 au kilomètre carré passerait, selon la variante "moyenne", à 75 en 2050 et à 102 en 2150. Quelle que soit la variante choisie et la durée de la projection, on ne pourra bientôt plus parler d'espaces vides dans le continent africain, comme on l'a souvent fait dans le passé.

L'accroissement de la population de l'Inde serait presque aussi spectaculaire de celle de la population africaine. Selon la variante "moyenne" la population de 853 millions en 1990 passerait à 1699 millions en 2050 et à 1949 millions en 2150. La densité actuellement de 275 au kilomètre carrés passerait à 520 en 2050 et à 596 en 2150, soit proche de celle du Bangladesh d'aujourd'hui. Et bien plus, selon la variable "moyenne haute".

La Chine, quant à elle, a subi un véritable traitement de choc depuis 1980 avec la politique rigoureuse que l'on sait, et elle aurait une croissance bien moindre au cours du prochain siècle. Le chiffre de la population passerait de 1139 millions en 1990 à un sommet de 1521 millions en 2050, pour redescendre à 1389 millions en 2150, toujours

selon la variante "moyenne". Par contre, selon la variante "moyenne haute", la population continuerait de croître jusqu'à 2367 millions en 2150. L'exemple de la Chine montre, ici encore, combien une politique efficace de réduction de la natalité peut avoir des effets sur le chiffre de la population puisque les deux variantes "moyenne" et "moyenne haute" conduisent à des chiffres qui peuvent différer de un milliard environ. Il paraît plausible de ne pas retenir la variante "moyenne haute", car si le pays s'engageait sur cette trajectoire on peut gager que le gouvernement interviendrait avec les moyens et le succès que l'on sait pour freiner la croissance.

Selon les deux variantes, la population de l'Inde dépasserait de très loin celle de la Chine dès 2050. Or, la superficie de l'Inde est trois fois inférieure à celle de la Chine, qui comporte il est vrai plus d'espaces désertiques et montagneux.

Le gigantisme de nombre de pays asiatiques ira en s'accroissant, non seulement pour ce qui concerne l'Inde et la Chine, mais encore le Bangladesh, l'Indonésie, le Japon, le Pakistan, les Philippines, la Thaïlande, pays qui compteront tous une ou plusieurs centaines de millions d'habitants avant la fin du prochain siècle. Ce sera une des données essentielles des 21<sup>ème</sup> et 22<sup>ème</sup> siècle, car cela va inéluctablement avoir des conséquences, d'abord sur les densités, ensuite sur l'urbanisation, alors que nombre de villes ont des populations atteignant déjà une dizaine, voire une vingtaine de millions d'habitants, sur les migrations internes et internationales, sur l'environnement dans les villes, sur les échanges commerciaux, la plupart étant déjà entrés dans un processus de croissance économique plus rapide même que celui des pays actuellement développés. La région va constituer un énorme bassin de consommateurs et de producteurs qui ont déjà démontré une capacité d'adaptation aux technologies les plus modernes.

Nous assistons à un déplacement du centre de gravité mondial vers la région Asie-Pacifique pour des raisons à la fois économiques et démographiques. La population de l'Asie, selon la projection "moyenne" des Nations unies, continuera de représenter environ la moitié de la population mondiale pendant encore 150 ans. On peut tabler que la mutation démo-économique de la région Asie-Pacifique devrait permettre, en l'espace d'une vie, de sortir de la pauvreté des millions d'habitants de la région.

Mais l'on pense évidemment aussi aux conséquences des densités élevées du point de vue des catastrophes naturelles, comme les inondations qui affligent déjà le Bangladesh, les typhons aux Philippines, les tremblements de terre qui menacent à peu près tous les pays de la région. Chaque année on compte 120 tremblements de terre dans le monde, dont l'intensité, mesurée en échelle de Richter, est comprise entre 6 et 6,9.

Les projections démographiques posent bien d'autres interrogations. Tenons-nous en encore à la variante "moyenne", quel que soit le scepticisme que l'on puisse éprouver à son endroit. On est pris de doute sur l'hypothèse du déclin de la fécondité pour l'Afrique, compte tenu de l'absence de conditions économiques et sociales devant accompagner ce déclin selon ce qu'enseigne la théorie de la transition démographique. L'indice synthétique de fécondité diminuerait de moitié en 30 ans, passant de 6 à 3 naissances par femme entre 1990-95 et 2020-25. Cela passe encore pour l'Afrique du Nord où le taux de prévalence de la contraception atteint ou dépasse 60 pour cent. Mais cela est peu admissible pour l'Afrique sub-saharienne où le taux de prévalence est de l'ordre de 10 pour cent seulement.

De même, l'Inde, dont l'indice de fécondité a très lentement baissé ces dernières 40 années, en dépit de l'attitude très favorable à la contraception des gouvernements, atteindrait selon la variante "moyenne" dès 2020-25 un niveau assurant tout juste le renouvellement des générations. Le Bangladesh serait dans la même situation. Or, la baisse de la fécondité dans ce pays, l'un des plus défavorisés par son environnement, vient à peine de commencer.

### **3.3. Une nouvelle interprétation de la théorie de la transition démographique**

Une nouvelle interprétation de la théorie de la transition pourrait venir à l'appui des hypothèses de baisse de la fécondité en l'absence d'amélioration suffisante des conditions économique et sociales (Tabah, 1983, 1993). Jusqu'ici l'adoption de pratiques contraceptives était conditionnée par un "terrain d'accueil" fait d'une certaine amélioration du niveau d'éducation, du statut de la femme, et de façon générale de meilleures conditions de vie. Il n'est pas exclu que nous assistions à ce que l'on pourrait appeler le développement d'une "contraception de pauvreté", facilitée par la diffusion intensive de la propagande en faveur de la limitation des naissances au moyen de communications de masse de plus en plus puissants, et atteignant toutes les couches de la population. On peut gager qu'à l'avenir les moyens modernes de contraception seront à la portée de toutes les populations, riches ou pauvres, et que les facteurs d'inhibition de leur utilisation disparaîtront progressivement. De telles propagandes sont déjà à l'oeuvre en Asie, en Amérique latine, et même au nord du Sahara. Par contre, elles sont très timides, sinon inexistantes, au sud du Sahara.

Autant on peut penser que les hypothèses sur la baisse de la fécondité des projections des Nations unies paraissent plausibles pour les nouveaux pays industriels de l'Asie (Chine, Indonésie, Malaisie, Philippines, Thaïlande), le Viet Nam, l'Afrique du Nord, l'Amérique latine presque entière, autant ces hypothèses paraissent peu vraisemblables pour l'Afrique sub-saharienne, l'Inde, le Bangladesh, le Pakistan, l'Afghanistan, certains pays du Proche-orient.

Cela nous amène à une observation d'une grande portée du point de vue des relations entre la croissance démographique et l'environnement.

Les pays de la première catégorie, ceux pour lesquels nous pensons que la baisse de la fécondité dans la variante "moyenne" est plausible, sont déjà largement entrés dans la transition démographique, et ils parviendront dans les prochaines décennies au terme de cette transition.

Considérons, en effet, pour ces populations le moment où l'indice synthétique de fécondité tomberait à 2,5 naissances par femme, soit un niveau semblable à celui des pays actuellement développés, vers 1965, et le chiffre des habitants à ces moments, toujours selon la projection "moyenne" des Nations unies (1988, 1990). Le calcul est présenté dans une étude de Tabah (?).

On constate, d'abord, qu'en 1985 très peu de pays du Tiers monde avaient un taux de fécondité inférieur à 2,5, en dehors du cas du pays actuellement le plus peuplé du monde, la Chine, ou de petits pays, tels Ile Maurice, Hong Kong, Barbado, Cuba, Martinique, Porto-Rico. Entre 1985 et 1990, ce sont encore des pays de dimension relativement faible, à part la Corée du sud avec 44 millions d'habitants et la Thaïlande, avec 46 millions d'habitants, qui étaient dans cette catégorie, tels Sri Lanka, Guyane,

Jamaïque. Vers la fin de ce siècle de grands pays entreraient dans la catégorie, presque essentiellement en Asie et Amérique latine: Indonésie, Viet Nam, Malaisie, Fidji, Turquie, Argentine, Chili, Colombie, Mexique, Costa Rica, Panama. Entre 2010 et 2020 de nombreux pays feraient à leur tour leur entrée dans la catégorie: en Afrique du Nord (Algérie, Egypte, Maroc), en Amérique latine (Brésil, République Dominicaine, Equateur, Pérou), ou en Asie (Inde, Philippines, Myanmar, Koweït, Bahreïn). Enfin, en 2020–25, on trouverait trois pays africains seulement (Afrique du Sud, Ghana, Cap-Vert), certains pays du Proche-Orient (Iran, Jordanie, Emirats Arabes Unis), et surtout trois grands pays asiatiques: Bangladesh, Pakistan, Cambodge.

Vers 2025, une longue liste de pays en développement se trouverait dans une deuxième catégorie: ceux qui seraient encore très loin d'achever leur transition démographique. On trouve dans cette liste 40 pays africains, 8 latino-américains et 8 asiatiques d'importance numérique relativement faible (dont 5 du Proche-Orient).

### 3.4. Quatre groupes de pays

On peut dès lors diviser le monde de 2025, du point de vue démographique, en quatre groupes selon les situations dans la transition démographique:

**Premier groupe.** Les pays actuellement développés au-delà de la transition démographique (Europe, Amérique du Nord, Océanie, ancienne URSS) dont la population serait estimée à 1237 millions d'habitants en 2025 et 1191 en 2100.

**Deuxième groupe.** Les pays nettement entrés dans la transition démographique, mais appartenant encore au Tiers monde, et qui seront les premiers à s'en détacher: la Chine et d'autres pays d'importance démographique faible, tels Ile Maurice, Hong Kong, Barbade, Cuba, Martinique, Porto Rico, République de Corée. Pour simplifier l'analyse nous ne retiendrons dans ce groupe que la Chine. Bien que les taux de fécondité soient faibles, de l'ordre de 2 naissances par femme, ou peu supérieurs, les taux de croissance sont encore nettement positifs en raison du potentiel d'accroissement accumulé dans les structures par âge. La population de la Chine en 2025 serait de 1513 millions, et 1405 en 2100, toujours selon la variante "moyenne".

**Troisième groupe.** Il est constitué de pays qui seraient en 2025 sur le point de parvenir à l'achèvement de la transition, ce qui ne veut pas dire, ici encore, que leur croissance serait nulle à cette date en raison du potentiel acquis et qui demandera encore plusieurs décennies pour s'éteindre complètement. Ils sont dans ce que Keyfitz (1994) appelle une "transition intermédiaire". La population du groupe en 2025 serait de 3922 millions, avec la répartition suivante: Afrique 306 (dont Afrique sub-saharienne 105, Afrique du Nord 201), Amérique latine 573 (dont Caraïbes 24, Amérique centrale 159, Amérique tempérée 70 et Amérique tropicale 320), Asie 3043. La population du groupe serait de 5860 millions en 2100.

**Quatrième groupe** Il serait constitué de pays dont la fécondité serait en 2025 supérieure à 2,5, donc encore loin d'achever leur transition démographique. Il comprendrait 1832 millions d'habitants en 2025, avec la répartition la suivante (en millions d'habitants): Afrique 1292 (dont Afrique sub-saharienne 1218, Afrique du Nord 73), Amérique latine 184 (dont Caraïbe 26, Amérique centrale 54, Amérique tropicale

104), Asie 357. On peut considérer qu'en 2100 seule l'Afrique sub-saharienne subsisterait dans le groupe. Il comporterait alors 2730 millions d'habitants.

Du point de vue de l'importance numérique le *Groupe 1*, celui des pays actuellement développés, est le plus faible et il le resterait selon toutes probabilités jusqu'en 2025, et bien au-delà, jusqu'à la fin du siècle.

Le *Groupe 2*, constitué par la Chine, serait à lui seul en 2025 d'importance déjà très supérieure à celle des pays actuellement développés.

Le *Groupe 3*, celui des pays du Tiers monde entrés dans la transition démographique à une allure qui peut être qualifiée de rapide, et dans lequel l'Asie aurait une part dominante, serait le plus nombreux en 2025, et le resterait au moins jusqu'à la fin du prochain siècle et le milieu du 22<sup>ème</sup> siècle. Il comporterait 1322 millions d'habitants en 1990, 3922 millions en 2025 et 5860 millions en 2100.

Le *Groupe 4*, dans lequel l'Afrique sub-saharienne aurait une part dominante, aurait, en 2025, 1832 millions d'habitants. Il serait celui qui croîtrait le plus rapidement au-delà de 2025, puisque l'Afrique seule atteindrait 2730 millions d'habitants à la fin du prochain siècle. Et, cependant, comme nous l'avons vu, l'hypothèse de la baisse de la fécondité de la région dans la variante "moyenne" des projections nous a paru optimiste.

On peut penser que les populations de ces quatre groupes exerceront des pressions différentes sur les ressources et l'environnement.

Le *Groupe 1* et le *Groupe 4* sont relativement homogènes. Le premier représente, du point de vue de l'environnement, tous les risques inhérents à la richesse. Il est celui qui consomme le plus de ressources naturelles et pollue le plus par son industrialisation, son agriculture intensive, et ses normes de consommation. Il y a tout lieu de penser que cette situation continuera au cours des décennies à venir, mais on peut penser aussi que ce groupe est le mieux équipé pour développer des technologies appropriées pour faire face aux problèmes créés. Seront-elles suffisantes et disponibles en temps opportun? C'est la question fondamentale qu'il faut se poser.

Le *Groupe 3* est très hétérogène. Il comporte des pays parvenus à une forme avancée d'industrialisation, fortement compétitifs avec ceux du *Groupe 1* sur le plan économique. C'est notamment le cas de la Corée du sud, de Taïwan, Hong Kong, Singapour. L'industrialisation y a été facilitée par des réformes agraires, comme ce fut le cas de la Corée dès après la guerre de 1950-53. Leur fécondité est basse, et en fait presque plus rien ne les distingue des pays riches sur le plan démographique comme sur le plan économique. On aurait dû les ranger dans la catégorie des pays riches il y a dix ou vingt ans, dont ils ont toutes les caractéristiques: usines avec chaînes de montage, éducation de masse, fort développement des mass media, urbanisation élevée avec embouteillages, pollution. D'autres pays de ce deuxième groupe ont une économie dont la dominante reste agraire, comme l'Inde, mais qui s'industrialisent aussi rapidement, et occupent une place grandissante sur la scène économique internationale, notamment ceux que l'on appelle les nouveaux pays industriels de l'Asie (Indonésie, Thaïlande, Malaisie). Il en est de même du Brésil, du Mexique, de la Colombie. L'hétérogénéité intérieure dans ces pays est aussi très grande. On y trouve simultanément une économie agraire, une économie industrielle souvent poussée, et

un développement des services, avec les formes de pollution caractéristiques de ces trois phases.

Les *Groupe 2* et *3* méritent bien l'appellation de "pays en développement". Ils sont impressionnants par leurs dimensions démographiques actuelles et potentielles, et par les changements dans les modes de vie. En seulement 35 ans le *Groupe 3* sortirait de la transition démographique, qui historiquement s'est toujours caractérisée par un processus d'industrialisation, et il entrerait nécessairement, si ce n'est déjà le cas, dans un enchaînement industrialisation-pollution et consommation accrue de ressources naturelles. C'est la situation qui prévaut depuis des décennies dans le *Groupe 1*, mais sans que ces pays disposent encore de technologies et de moyens de conservation de l'environnement, ou encore sans volonté politique de les utiliser. Dès 2025 le rapport des populations entre le *Groupe 1*, d'une part, et l'ensemble des *Groupe 2* et *3*, d'autre part, serait de 1 à 3. En 2050 le rapport dépasserait 1 à 5, et 1 à 6 à la fin du siècle prochain.

Enfin, le *Groupe 4*, présente les risques pour l'environnement inhérents à la pauvreté. Ces risques vont trouver des limites contrairement à ceux du premier groupe. Il ne cesserait d'augmenter démographiquement jusqu'au dernier quart du siècle prochain. Il est affligé de problèmes déjà graves d'environnement (désertification, déboisement, insuffisance et pollution d'eau, etc). La priorité majeure est de subvenir aux besoins fondamentaux immédiats, plutôt que de préserver un futur dont l'horizon est court et se compte en termes de jours ou de semaines de subsistances. On peut considérer que seule l'Afrique sub-saharienne demeurerait dans ce groupe à la fin du siècle prochain.

En résumé, les poids démographiques seraient les suivants:

Année	(chiffres en millions)		
	1990	2025	2100
<i>Groupe 1</i>	1089	1237	1191
<i>Groupe 2</i>	1139	1513	1405
<i>Groupe 3</i>	1322	3922	5860
<i>Groupe 4</i>	1742	1832	2730
Total	5292	8504	11186

### 3.5. Projections sur la pollution et le réchauffement du globe

Dans divers modèles traitant de l'évolution du climat il est supposé que l'émission de gaz carbonique dépend de cinq facteurs: volume de la population; PNB par tête; intensité d'énergie, c'est-à-dire rapport entre la consommation d'énergie et le PNB; intensité du charbon, c'est-à-dire rapport entre la consommation de charbon et la consommation totale d'énergie fossile; déforestation.

On prend généralement le taux d'émission du gaz carbonique comme indicateur du degré de pollution, car il serait responsable pour deux-tiers de la pollution, et on établit une relation entre le degré de pollution et le réchauffement du globe.

Nous nous baserons sur les scénarios du Comité Intergouvernemental sur le Changement de Climat (IPCC, 1991) établi sous les auspices du Programme des Nations unies pour l'Environnement et l'Organisation Météorologique Mondiale, ainsi que le Rapport au Congrès des Etats-Unis présenté par l'Agence Américaine pour la Protection de l'Environnement (EPA) discutés par N. Birdsall (1992), Bongaarts (1992) et par le Réseau d'Action sur le Climat (Climate Action Network, CAN, 1993).

Les calculs sont effectués en termes de tonnes de gaz carbonique émis. On peut faire les observations suivantes:

- Sur 5.15 milliards de tonnes émises en 1985, 3.83 furent le fait des pays développés et 1.33 des pays en développement. Les différences par tête furent beaucoup plus marquées: 3.12 et 0.36 millions de tonnes respectivement.
- Entre 1985 et 2025, la quantité de gaz carbonique émise devrait plus que doubler, et la croissance aurait été beaucoup plus vive dans le Tiers monde que dans les pays actuellement industrialisés. Le chiffre global serait de 12.43 milliards de tonnes en 2025, répartis entre 6.95 pour les pays actuellement développés et 5.48 pour les pays actuellement en développement. L'émission des pays asiatiques serait déjà en 2025 l'équivalent de l'émission des pays développés en 1985 (3.83 milliards de tonnes pour les pays développés en 1985, et 3.90 pour l'Asie en 2025). La Chine seule émettrait 1.80 milliards de tonnes en 2025, soit plus que les Etats-Unis de 1985 (1.34 milliards de tonnes). Les pays asiatiques constituent ce que nous avons appelé le *Groupe 2* (Chine) et les trois quarts du *Groupe 3* (3043 millions d'habitants sur les 3922 millions que compterait ce groupe).
- L'émission de gaz carbonique par tête ne cesserait d'augmenter d'ici à 2025, ce qui montre bien que le facteur démographique est loin d'être seul en jeu. Même en l'absence de croissance démographique les émissions de gaz carbonique continueraient. La croissance d'émission par tête serait plus forte dans le Tiers monde que dans les pays actuellement développés. Les émissions par tête seraient pour les pays actuellement développés de 3.12 tonnes en 1985 et 4.65 en 2025. Pour les pays actuellement en développement les chiffres seraient respectivement de 0.36 tonnes et 0.84 tonnes. On assiste ainsi à un processus de "rattrapage" du Tiers monde par rapport aux pays riches dans la pollution. Ces scénarios contredisent donc la convention signée sur le climat à Rio demandant l'arrêt des émissions.
- La relation quantité de gaz carbonique émise par rapport à un dollar de PNB, ce que nous avons appelé intensité d'énergie, est beaucoup plus élevée dans les pays du Tiers monde qu'elle ne l'est dans les pays riches. Alors que l'émission serait de 276 grammes pour un dollar de PNB dans les pays riches, elle serait de 2024 grammes en Chine, de 655 grammes en Inde, 374 grammes en République de Corée et 170 grammes au Brésil. Les chiffres élevés de la Chine et de l'Inde s'expliquent en partie par le fait que ces deux pays fondent leur développement sur le charbon plutôt que sur d'autres formes d'énergie, autrement-dit ont une intensité charbon élevée. N. Birdsall (1992) explique que les pays du Tiers monde dans les premières périodes de leur développement, passant d'une économie agraire à une économie plus industrielle, utilisent plus d'énergie par unité de PNB produite que les pays riches, dont l'évolution tend à passer des industries aux services nécessitant moins d'énergie. Mais, ce qui importe pour le

réchauffement du globe c'est moins les émissions nouvelles—les flux— que les concentrations—les stock accumulés—car les gaz sont retenus dans l'atmosphère pendant de longues périodes, et pour le moment les concentrations sont plus le fait des pays riches que des pauvres.

- On considère que les émissions entraînées par le déboisement constituent environ 20 pour cent du gaz carbonique émis et 50 pour cent du gaz émis par l'ensemble des gaz. Cependant, il y a des limites à cette source d'émission, car le déboisement a atteint dans bien des pays des taux très élevés et ne peut continuer au même rythme. Ces émissions vont se poursuivre pendant encore quelques décennies. Elles sont surtout le fait de ce que nous avons appelé le *Groupe 4*, et pour une part décroissante du *Groupe 3*.
- L'émission de gaz carbonique est appelée à s'accroître en tout état de cause, même si les pays développés parvenaient à émettre moins de gaz par dollar produit, et si les pays du Tiers monde ajustaient leurs émissions au même niveau que les pays riches en 2100. Dans l'hypothèse relativement optimiste, où l'émission tendrait partout vers 1.2 tonnes par tête, soit l'émission moyenne actuelle, N. Birsdall (1992) calcule que l'émission totale en 2100 serait encore de 12.0 milliards de tonnes, soit plus de deux fois l'émission de 1985. Cette hypothèse suppose que des mesures portant sur les cinq facteurs retenus responsables de l'émission de gaz carbonique seraient dès maintenant commencées. Or, ce n'est malheureusement pas ce que l'on observe deux ans après la Conférence de Rio.
- Les modèles de l'IPCC et de l'EPA conduisent à un réchauffement de la planète d'ici à 2100 de 2.5 degrés si les émissions sont stabilisées au niveau de 1990 et de 4. 2 degrés si la stabilisation est ajournée à 2075. Cette stabilisation devrait intervenir simultanément dans tous les pays, riches ou en développement.

Bongaarts (1992), en discutant ces modèles, est parvenu à la conclusion que l'accroissement démographique contribuerait pour 35 pour cent à l'émission de gaz carbonique dans l'atmosphère entre 1985 et 2100. La part des pays en développement dans l'émission totale passerait de 36 pour cent en 1985 à 44 pour cent en 2025 et 54 pour cent en 2100.

#### 4. Conclusions et recommandations

Ce qui frappe d'abord dans cette vue d'ensemble de la littérature récente traitant des interrelations entre la population, les ressources et l'environnement, est l'absence de vues fondamentalement divergentes de la part des chercheurs, contrairement à ce que l'on observe dans les débats politiques. Les incertitudes et les doutes sur le plan scientifique ne manquent cependant pas et il en sera ainsi tant que l'on n'aura pas fait un réel inventaire des problèmes de l'environnement de la planète, un bilan de santé, comme on dit. Les données sont, en effet, encore fragiles, surtout dans le Tiers monde. Et, sans nul doute, faut-il commencer par améliorer la collecte des données dans un cadre théorique de référence encore absent. En protégeant la diversité des sources d'information.

Quel est le degré d'information sur les questions des interrelations entre la population et l'environnement? Une grande enquête comparative mondiale sur des données

objectives de l'environnement, nécessairement limitée à quelques points, relatifs à la démographie, ou sur la perception des problèmes de l'environnement, comme on l'a fait pour la fécondité, avec une quarantaine de pays en développement et la presque totalité des pays industriels, s'avérerait hautement désirable.

La priorité devrait porter sur la collecte de données dans les zones particulièrement fragiles écologiquement, où la pression démographique est forte. Il faut aussi identifier les groupes de population particulièrement vulnérables parce que résidant dans ces zones et qui nécessitent donc une assistance technique et financière. Il faut porter une attention particulière aux groupes de population susceptibles de doubler rapidement, ou au contraire celles en bonne voie de décélération, et observer les comportements et attitudes du point de vue de la consommation et de l'environnement de ces groupes.

Toutes les recherches montrent que le facteur démographique joue un rôle important dans la détérioration de l'environnement, en conjonction avec bien d'autres variables, notamment économiques, sociales, politiques. Aucune de ces variables n'agit indépendamment des autres.

L'analyse des projections démographiques des Nations unies et de la Banque mondiale est d'une exceptionnelle importance. Ces projections montrent, une fois de plus, la très grande sensibilité de l'évolution démographique mondiale à l'évolution de la fécondité, et elles mettent ainsi en évidence tout l'intérêt qu'il faut attacher aux programmes de planification des naissances dans le Tiers monde. Ces programmes permettent d'accélérer la transition démographique sans attendre le plein développement. Leur succès permettrait d'éviter que la stabilisation de la population ne s'effectue à des niveaux très élevés et dommageables pour l'environnement. Mais, en même temps, en accélérant la transition démographique, et donc la consommation, ils rendent plus urgentes les mesures de conservation de l'environnement. C'est pourquoi il paraît indispensable d'associer étroitement les politiques de maîtrise de la croissance démographique et les actions de protection de l'environnement. Les deux actions devraient être indissociablement liées. Ce qui implique de meilleures liaisons entre les institutions nationales et internationales traitant de ces questions, qu'il s'agisse de l'assistance technique ou financière.

Du point de vue du développement, comme de la préservation de l'environnement, l'action doit veiller à ce que la variante "moyenne" plutôt que la "moyenne haute" des projections démographiques des Nations s'inscrive dans le futur. Ce devrait être une recommandation fondamentale. Cette recommandation devrait s'appliquer en toute priorité aux pays actuellement développés (*Groupe 1*) car la variante "moyenne haute", au reste assez peu plausible pour ces pays, amènerait les populations à doubler d'ici à la fin du siècle prochain. Ces pays sont déjà responsables des deux tiers des émissions de gaz carbonique dans l'atmosphère, et donc de l'effet de serre et du réchauffement de la planète.

Mais ces projections montrent aussi que la grande masse du Tiers monde est également en voie d'achever la transition démographique vers 2025. Certains peu avant, d'autres peu après. Ce serait le cas du *Groupe 2* (Chine) et du *Groupe 3* (presque l'ensemble des autres pays asiatiques et des principaux pays d'Amérique latine). Ces deux groupes formeraient alors les deux tiers de la population mondiale, soit une masse de 5435 millions d'habitants dès 2025, qui s'ajouterait aux 1237 millions du *Groupe 1*, et 7265 millions en 2100 s'ajoutant aux 1191 millions du *Groupe*

1. Or, qui dit fin de la transition démographique dit aussi nécessairement croissance de consommation, industrialisation, et donc aussi pollution. Et, de fait, les dernières statistiques économiques du Tiers monde font état de progrès économiques rapides, au prix il est vrai d'un coût social élevé, dépassant souvent nettement ceux des pays riches. Ce que nous avons tous appelé de nos vœux depuis longtemps. C'est d'abord le cas de la Chine dont le taux de croissance démographique est tombé aux alentours de 1 pour cent, mais aussi des "nouveaux pays industriels" de l'Asie (Hong Kong, Indonésie, Malaisie, Singapour, Thaïlande), et même de l'Inde, plus récemment du Viet Nam, des grands pays d'Amérique latine (Argentine, Brésil, Chili, Colombie, Mexique, Pérou). On observe, pour la première fois, nombre de pays du Tiers monde dont les taux de croissance du PNB sont très supérieurs aux taux de croissance de la population. Certes, ces pays ont encore un long chemin à parcourir pour réduire la distance sur le plan économique et social qui les sépare du *Groupe 1*. Leurs habitants vont pendant longtemps polluer chacun moins que ne le font ceux des pays riches, car les consommations ont encore du retard. Mais la pression sur l'environnement sera considérable par la masse démographique. Ces deux groupes deviendraient responsables de 44 pour cent des émissions de gaz carbonique dès 2025, et de 54 pour cent à la fin du prochain siècle, comme le montrent les modèles des institutions internationales spécialisées sur le climat.

Quant au *Groupe 4*, dans lequel l'Afrique sub-saharienne occupe une place dominante, il présente toutes les caractéristiques d'une "pollution de pauvreté", occasionnée surtout par le déboisement. Pour le moment sa contribution aux émissions de gaz carbonique dans le monde est relativement faible et, d'autre part, cette source de pollution va connaître des limites car le déboisement est souvent devenu tel que la forêt est réduite à cause même du déboisement. Le groupe est dépourvu de moyens permettant de prendre des mesures pour la conservation des sols qui sont la base même de la survie des populations. Les dégradations causées sont d'une plus grande gravité pour la région que pour le reste du monde, et notamment pour son agriculture. Elles continueront tant que l'on aura pas éradiqué la pauvreté elle-même.

Le temps presse car les évolutions à la fois démographiques et écologiques sont rapides à l'échelle de l'histoire de la biosphère. Il est urgent que les pays riches "remboursent" en quelque sorte leur "dette écologique", en transférant ressources et technologies moins polluantes au Tiers monde, même s'ils maîtrisent encore eux-mêmes très imparfaitement ces technologies. Il faut pour cela une volonté politique planétaire, qui malheureusement n'a pas été réellement démontrée à la Conférence de Rio sur l'environnement de 1992.

Une stabilisation immédiate des émissions de gaz carbonique dans l'atmosphère est assez peu réaliste, car on ne possède pas encore les technologies appropriées. D'autre part, le Tiers monde revendique un certain délai pour mettre en oeuvre les mesures de conservation et d'aménagement de l'environnement sans compromettre les efforts de développement. Cependant, les deux objectifs devraient être menés de front si l'on vise un développement durable.

Cela ne veut évidemment pas dire que le Tiers monde devrait attendre, pour commencer une oeuvre d'assainissement de l'environnement, que les ressources et les technologies venues de l'extérieur soient disponibles.

Bien entendu, on aurait tort de tout réduire aux questions techniques et penser qu'il suffit de colmater les brèches de l'environnement, et de distribuer dans le Tiers monde des contraceptifs. La technique ne peut être qu'un remède partiel. Il faut agir plus au niveau des motivations qu'au niveau des moyens. Diffuser la contraception dans le Tiers monde sans agir sur les facteurs du milieu sociétal serait une entreprise irrémédiablement vouée à l'échec.

Il importe de mettre en lumière l'intérêt croissant d'une action qui se situerait en amont des détériorations de l'environnement.

Il faut élever le niveau de conscience des populations par un effort pédagogique montrant qu'au niveau de chacun on ne peut plus séparer l'évolution démographique des espèces vivantes de l'éco-évolution de la biosphère qui nous entoure.

On devrait faire une distinction entre les problèmes qui devraient être traités immédiatement, tels les combats contre la déforestation, la désertification, et toutes sortes de pollutions (air, eau, sols), et ceux au niveau sociétal, comme l'insuffisance d'accès au planning familial, la lutte contre l'inégalité sociale, ou ce qui concerne l'inégalité de condition entre les deux sexes, la réforme agraire, le ralentissement des flux d'immigrants vers les villes insalubres et surpeuplées, ainsi que l'a proposé une réunion du CICRED (1992).

Il faut donner au terme population un contenu qui ne soit pas purement démographique, élargissant considérablement son acception. Il faut aussi donner au terme environnement un sens dynamique en le considérant comme le support d'un potentiel de ressources qu'il appartient de valoriser par l'application de technologies appropriées sans cesse renouvelées. Les actions de correction du milieu, ou les actions de conservation des ressources, ne peuvent se concevoir en dehors du concours de la population, notamment à travers ces corps intermédiaires que sont les communautés de villages ou de villes qui sont des instruments puissants de libération des capacités d'innovation. "A portée de voix" si l'on peut dire. Pour la première fois, l'action sur l'environnement donne une chance à la population d'agir elle-même pour influencer l'avenir de la communauté à laquelle chacun appartient. Il faut redonner vigueur aux citoyennetés locales.

Il faudra donc s'appuyer sur les systèmes locaux d'organisation et de gestion des communautés, tirer le meilleur parti possible des technologies et des ressources locales, tant pour affronter les questions d'environnement que de population.

Enfin, il convient d'agir auprès des organisations capables d'apporter une coopération à l'échelle locale, nationale ou internationale. Dans la mesure où il existe des institutions nationales consacrées aux questions de l'environnement il faudrait s'enquérir de la place et du rôle dévolus à la démographie par ces institutions.

Toutes les recommandations du Groupe d'experts sur La Population, l'Environnement et le Développement réuni du 20 au 24 janvier 1992, aux Nations unies à New York, en vue de la préparation de la Conférence mondiale sur la population et le développement qui se tiendra au Caire en septembre de cette année, ne peuvent que retenir notre entière adhésion. Aussi nous invitons le lecteur à s'y reporter.

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## CHAPTER 3

# BUILDING A PRODUCTIVE, EQUITABLE AND SUSTAINABLE SOCIETY: A THREE-KEY OPENING TO ASSURED AND CONTINUING DEVELOPMENT

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### 1. Introduction

Three qualities are needed for a society to be workable in our late 20th century. It has to be productive, it has to divide its benefits, i.e. the consumption that productiveness makes possible, in a way that will be perceived as fair, and the nature of its system of production and consumption have to be such that it is not eating into the capital that nature has placed at its disposal. Not only is any one of these qualities insufficient but so are any two--all three are absolutely indispensable. The thesis of the paper is that if any one is missing a breakdown is inevitable. In different ways population is related to all three.

It takes two keys to open a bank deposit vault, and a few years back we heard about a two-key system for the nuclear deterrent, the discussion being always dominated by the need for security. The system had to work if the occasion ever required, and it had to be proof against accidental or criminal triggering. I argue that three keys are needed for a present-day society, and if one is missing a breakdown will occur, the nature of the breakdown being different for different missing elements.

The three locks that have to be opened are easily named: one is the laws of economics, one is the laws of political change, one is the access to natural wealth. The three essentials for development cannot be ranked in importance, for they are incommensurable with one another, all independently indispensable. Nor is there any other major requirement; with these three keys durable development will click into place.

Examples are plentiful of actual or potential disaster when one or two of the three essential elements is lacking. In the Shah's Iran there was high productivity, but no concern for equity. In the USSR there was plenty of concern--at least in theory--for equity but none at all for sustainability, and productivity was neglected to the point where especially in recent years it fell sharply. The current condition of Russia if present policies do what is expected of them will probably eventuate in high productivity of those who exercise initiative, but very low equity, and the political pressures that would upset it are very much in sight today. Japan is high on productivity and equity--its ratio of executive to worker pay is lower than in most European countries and far lower than in the United States--but it does have environmental problems, and its effectiveness in dealing with these is crucial for its continued success.

The United States is high on productivity and environment, but low on equity, and it will face increasingly serious internal conflict if equity is not dealt with. Currently proposed health legislation has essentially nothing to do with health, but only with the financing of a level of care for those of average and below average income that is already enjoyed by those better off. No one is complaining about the quality of American medical facilities, but only about their availability. We see intense political activity on the matter of access, and indeed most American politics are concerned with just this matter of equality; as Richard Lewontin (1994:31) says

"The central social agony of American political and social life since the founding of the Republic has been caused by the problem of equality. ...[There is] manifest inequality of status, wealth, and power in a society whose chief claim to legitimacy has been its devotion to equality".

## 2. Population: The Economic Aspect<sup>1</sup>

This provides the framework for treatment of population, that enters each of the three conditions for development.

In its economic aspect, the relation of population to development has changed with the generations. During the first half of this century it was still dominated by Malthus: there is so much land, and so much only, and population has to stop growing at a certain point, which is not far off, or there will be starvation. A paper by Richard Nelson (1956), an economist in good standing, described the equilibrium that would result if food set a limit to population increase, and it was well received.

Then for a generation agricultural productivity was rising rapidly, and it seemed as though Malthus's food constraint no longer applied, but one quoted Arthur Lewis (1955), Ansley Coale (1958) and others who saw capital as limited, so that more people would each have less of the capital that was available. After all, the new entrants into the labor market have to be equipped if the workforce as a whole is to maintain its productivity. It was as though physical capital was not made by people (in any case not by the people in the less developed countries (LDCs)), but it had to be bought (mostly from the United States at the time when this view was current). If there was only so much money from exports, borrowings, etc., then the amount of capital would be inextensible, i.e. would not increase with the number of people, so there would be less per capita as population grew. Capital was treated somewhat as land had been treated in the previous (Malthusian) theory.

And in the most recent period there is a further change in the economic perspective. Land is still not constraining, but capital also has become less important. For one thing, extensive research on the development of the presently rich countries failed to account for any large part of their progress by the amount of capital they employed. Beyond that, the LDC has a rich asset in its low-paid labor, and internationally oriented enterprises seek to establish factories where labor is cheap; the labor should draw the capital. And this is indeed what we see happening as secondary industry flourishes in East and Southeast Asia, largely through Japanese and American direct investment. And even more basic than that, Adam Smith's (1776) specialization that is made possible by a larger market, would by itself encourage increased population. With this theory alone,

omitting the questions of equity and ecology, population can continue to grow indefinitely.

This last has been called "revisionism." But apparently it is in turn being revised. Allen Kelley and Robert Schmidt have looked hard at the economic data and they find that as among countries in the most recent period those with high economic growth tended on the whole to have lower population growth. A very useful survey of the literature is provided by Kelley (1988). It is a fair treatment of the diverse views within the discipline.

So it is not easy to say what economics thinks about population. Smith's size of the market, Malthus's limits, indefinite possibilities for stretching land and capital, the natural condition of full employment irrespective of the size of population, no relation and negative relation between population growth and economic growth, are all currently referred to. If one is bound to describe the view of the majority of economists today, then it is that population does not make much difference to the economy, that making birth control available is as much a matter of human rights as of economics. But on the whole, taking the corpus of economic literature as a whole, it appears that neither theory nor data provide a conclusive indication of the effect of population. One aspect of the uncertainty arises from disagreement on the possibility of genuine involuntary long-term unemployment--if there is no such thing as unemployment then a larger population will always be able to add something to the social product that it shares.

### **3. Population: Equality**

Economic theory in general is stronger on total and average income than it is on distribution, but in this matter there is an important theorem that does tell us a great deal. Ricardo's law of rent applies wherever land is important: with increasing population on the given territory the landowner will be better off, the farmer worse off. If we settle on Ricardo's tightly argued theory then one who favors equality would want as few people as possible.

More up to date, there is a strong and justified suspicion that the dual economy results from density of population, and that the two parts become increasingly separated with the growth of population (Todaro, 1989). If there are any limits at all on land and capital, and property rules apply, especially if there is inheritance through older sons, the number of the disinherited will increase rapidly once a certain size of population is attained. Latin American and other landlords wanted more people at any cost--without masses of people they would have to work their lands themselves. Their pressure for immigration only came to be tempered when the immigrants gathered in cities and became an independent political force.

What we see throughout the Third World is a growth of cities far more rapid than that of the population as a whole. In them is an accumulation of people who are dissatisfied with the living they can earn as landless laborers in their original rural communities. Yet the difficulty of finding a job in Jakarta or Calcutta, even for an educated young man or woman, is formidable. The unemployment of the 1930s in the West suggests the kind of difficulty one faces getting into the production circuits of Mexico City or Sao Paulo.

Led by their more educated members the excluded become a more and more powerful force for instability, capable of throwing the whole development process off the track. Examples will be given below.

#### 4. Population: Sustainability

The connection of population with sustainability is the closest and most direct of all. At any given level of the human-determined elements--productivity and equity--there is only so much of the nature-determined quantities. If beyond a certain point we consume natural capital we will be living on what our descendants would need if they are to live as well as we do. But the matter is more complex.

It is true that more people make possible the creation of more nature--people can plant trees, they can breed fish in ponds when the oceans become desert, under the pressure of population they can substitute common materials for scarce ones, they seem to be able to invent substitutes for nearly everything. What is awkward is that these activities modifying nature are never fully under control. At any given stage scientific knowledge is necessarily incomplete; we know something about cutting down tropical forests and replanting, but we do not know what species of the tropical forest survive with the change. (In any case there is insufficient economic and political incentive to replant fully.) As in fairy tales, science persuades nature to grant us our wishes, but then there turns out to be associated changes that make our condition worse than before.

Examples of this capacity of nature to hit back when we think we have it under control are everywhere (Wilson, 1992). We thought we had won out over disease forever with antibiotics, but now measles has come in as a serious adult disease, and malaria is increasing rapidly. A host of ailments that did not exist or were too rare to be diagnosed--AIDS and other venereal diseases, Lyme disease, legionnaires disease, are among those mentioned in the press. Our commercial activities are constantly upsetting one ecological balance or another. Fire ants are in the news at the moment; brought up from Argentina (where they are controlled by numerous enemies) with a shipment of plants, they have spread from Alabama north and west over the course of years, and now it looks as though they will reach California soon. With an incredible rate of increase and no enemies in the US capable of keeping them down, we seem to have tried chemicals that only made them spread faster, and now an attempt is being made at biological control. That means bringing up a selection of their enemies from Argentina, and it has to be done with circumspection, lest these in turn become pests.

It is based on experience such as this that scientists do not share the popular view that science can do everything. In its 1993 Statement, the National Academy of Sciences of the United States and the Royal Society of London have come as close as any such bodies have to speaking for the community of those who will produce the science that will make these marvelous transformations. The spirit of that document is given by such a statement as,

- If current predictions of population growth prove accurate and patterns of human activity on the planet remain unchanged, science and technology may not be able

to prevent either irreversible degradation of the environment or continued poverty for much of the world (Atiyah and Press, 1992)."

With their small numbers and their simple and stable techniques for gaining a livelihood, our hunting ancestors who emerged one or two million years ago did not greatly disturb the natural environment in which they lived. Say Lee and Devore (1968:3) of human existence before the Neolithic,

"The hunting way of life has been the most successful and persistent adaptation man has ever achieved."

The adaptation was based on a very long experience--people have lived by hunting a hundred times as long as they have lived by agriculture, and several thousand times as long as they have lived by industry.

But what those hunting cultures could not adapt to was the agricultural world of increasing populations and expanding economies. We need not speculate on whether the increasing population forced the change to agriculture, or whether agriculture, making food supplies more reliable, lowered mortality and so facilitated an increasing population. The fact was that at that relatively recent point in time--at most 10,000 years ago--the human race set off on its career of active intervention in the ecology of the planet and initiated our career of achievement and of destruction. Biologists do not say so, but one might think of a biological utopia that would consist of an evolution starting branching off from the pre-neolithic and taking a path very different from the agricultural-industrial trajectory that we know. I say this only to make a symmetry with the utopia of equality, that is equally unworkable, and is mentioned only to show that we do not get anywhere by unlocking any one of the three doors of this paper.

## **5. The Three Academic Disciplines**

I have chosen the title of this paper not because it is grandiose, which it unfortunately is, but in order to suggest the three disciplines that are needed for the study of development. On productivity it is economics that has most to say, on sustainability biology, and on equity political science and sociology. I submit that any one of these disciplines, notwithstanding its long history and distinguished practitioners, becomes grossly incompetent, even talks nonsense, when it professes to give the whole answer to the difficult questions arising out of the present predicament of individual countries and of our planet as a whole.

Think of two of the tests of a viable lifestyle: that all the world's inhabitants have a prospect of sharing it, and when so shared it can continue indefinitely. The pre-neolithic hunting and gathering culture failed only on the productivity test and so no one proposes choosing it as the model. But in covering only two of the three conditions--equality and sustainability--when productivity also is needed, leaves it entirely disqualified. No one proposes following the equity and environmental criteria and omitting the economic; is it similarly unjustified to follow the production criterion alone?

A completely free economy is as much an absurdity as a completely directed economy. If anyone wants evidence they can go to Russia, that was persuaded that "shock therapy" would enable it to go from communism to capitalism, and that it would immediately replicate the rise of the United States to its condition of high

productiveness. That was the application of pure economics to deal with a condition that was partly political, partly ecological. The economics could have been forecast to fail without the previous establishment of an infrastructure--means of communication, cadastral surveys, a reliable judiciary. No one seems to have made the distinction between free enterprise that serves the social interest on the one hand, and free enterprise in crime on the other.

For wanting to make a profit, to truck and trade, is natural as Adam Smith (1776) said, but he had in mind his pious Scottish countrymen, bred in a calvinistic tradition, who would feel constraints on what was permitted under freedom even if there had been no laws to tell them. Confining themselves to what was permitted by law was second nature for them, but it is evidently not natural for people who lost their internal guidelines in the course of two or three generations of communism. If people do not have a sense of what is legal and ethical bred into them from earliest years, then no amount of policing will keep them in order. When people will steal from their neighbour any time no one is looking, then the apparatus of justice is impotent, and this would apply even if there was an incorruptible police. It is sad to say, but without some social sense bred into the large majority of citizens the only way that order can be kept is by sheer terror. That is why I call free enterprise without any constraints of ethics and without effective constraints of law a capitalist utopia that is as unlikely to succeed as its opposite the communist utopia.

## 6. How Much Knowledge From Metaphors?

When a metaphor such as that of this paper is presented as a mode of exposition it is harmless enough; when it has no other backing, and pretends by itself to constitute evidence or proof it ceases to have a place in social science. Its unsupported use can be an indication that there is not a more conclusive way of dealing with the subject. I give some examples, particularly of matters relating to equity.

Economics deals straightforwardly and seriously with productivity, but it finds its methods less effective on employment and more generally on equity, as well as environment. Both equity and environment are difficult for it and it finds public concern with them exaggerated. When equity comes up in discussion economics tends to assert that people in rich communities may be temporarily excluded, but sooner or later will have their share of the nation's wealth. As the world become richer the poor, both those within rich countries and those of the countries where nearly everyone is now poor, will also benefit. True that the rich get the benefits of increased productivity and freer trade first, but all will benefit in the end so those who are left out initially should work and be patient.

One hears of "trickle down" and "a rising tide raises all boats", persuasive and reassuring images but hardly explaining how the economy works. What we know is that when the economy produces more goods they will somehow have to be disposed of; all those automobiles and washing machines have to be sold if production is to continue, but there is no agreement on whether the purchasing power needed for their purchase will suffice to move the increasing production off the dealer's shelves. That is why some think trade unions or other political means of forcing distribution are needed, not only to benefit labor, but to dispose of goods and so keep the productive machine going,

including the flow of income to the rich. Others favor fiscal remedies through taxation and redistribution, and others again consider that enabling consumers and producers to borrow more cheaply will do the trick.

We all know and fear the political instability engendered by failure to sell the product and the consequent dismissal and unemployment of the workers who have been producing them. Calling the dismissals "restructuring" (another metaphor) in the interests of efficiency does nothing to console those affected, and even generous unemployment compensation cannot make them overlook the symbolic meaning of their being dropped. It is worth taking a moment to see why unemployment, that affects only a minority—about 10 per cent in Europe, less in the United States—excites such concern. I will argue that losing one's job, or the mere possibility that one might lose one's job and not be able to find another, is to contemplate a disaster of which the loss of income may be only a small part.

To lose the sense of self-worth that derives from the day by day performance of typesetting or assembling of television sets; to lose the social connections with others doing similar work; to sense that now one is living on the cold and formal charity of the State; these are not easy to take. The only thing worse than having to get up in the morning and leave home to go to work is not having any reason for getting up and no place to go. That is for the older workers who are let out; for the younger who cannot get themselves inserted in the circuits of production and consumption there is sheer desperation, called to public attention by widespread demonstrations in the cities of France as this is being written. Showing itself in statistics of crime everywhere, and nowhere more than in the United States. It is true that US crime levels as a whole have stabilized, but crime by young males has risen sharply in the last few years.

Because of so-called social legislation mandating large severance payments, older workers in Italy are typically not dismissed before retiring age, but corresponding to this younger would-be workers, including many highly qualified, suffer especially long periods of waiting to "insert themselves" (a favorite Italian metaphor at the present time) into the productive system. We know that people's most useful skills are not learned at school or at home, but at work; kept from work they become month by month less capable of holding a job.

Rostow's "take-off" of a plane as an image of development is as persuasive as the rising tide that raises all boats, and ultimately just as unhelpful. His "stages" of development—preparation, accelerating down the runway, etc.—are attractive because they imply that once under way the continuance of development is virtually inevitable. But now that we see Brazil's promising industrialization of the 1970s so rudely checked, and the same in many other Latin American countries, we are ready to believe that advance on the economic front can be very easily stopped by bad policies dictated by political forces.

Allowing one's thinking to be captured by such images is one of the hazards of all social science and by no means of economics alone. So we must protect ourselves against them by seeing them as means of communication, never accepting them as evidence or proof unless they are closer to the phenomenon in question than Rostow's airplane.

## 7. The Expansiveness of Disciplines

Disciplines do not take well to division of labor among themselves. Each wants to deal with real problems, and tries to incorporate within itself all the elements necessary to do so, neglectful that some other discipline has been working on them. Let us examine one instance of many--the attempt of economics to embrace ecology.

When economics incorporates ecology it runs up against two major difficulties. For environment to enter economics, for example to be calculated into the Gross Domestic Product (GDP), it must be quantified, expressed in terms of money. One distinguished economist is quoted by the press as saying that at worst the damage being done to the environment now and in prospect could lower GDP by 1/4 per cent below what it would otherwise be. Yet climatologists who have devoted their lives to such matters as the global temperature, one component of the estimate of environmental damage, do not know whether there will be warming or whether our release of carbon dioxide will be offset by other things we are doing; if there is warming what its effects will be on the oceans and on various localities on land; and even if we knew the effects exactly we would only with much difficulty be able to estimate the cost of repairing the damage for some particular effect like rise of the oceans. Thus there are three wide gaps of knowledge in the special sciences dealing with these matters over which economics has to leap before it can deal with this particular question of environment: whether net damage will result from our practices at all, what the net damage will be, and how much will it cost to fix up.

But beyond these is a question of values that no discipline can deal with: since the damage and its repair will mostly occur in the future, how much the cost of what we are doing now has to be discounted in order to estimate the amount of present income we ought to be sacrificing to avoid or repair the effects of present activities. That raises the subject of social discount rates--to discount at commercial interest makes the future unimportant, while to discount at zero interest, for which a strong argument can be made, gives such high numbers that financing out of present income would be impossible. Moreover the calculation is more difficult than this implies, for it must also take into account the discounted help we will get from inventions that will enable us to avoid damage in the future, inventions not yet in sight and not even specifiable.

The ozone layer, another environmental element subject to damage, offers its own special difficulty: no one can forecast our effect on it, but suppose we somehow found out that what we are doing to make it thinner and so reducing its protective effect raises cancer rates by 10 per cent; how many dollars does the resulting rise in mortality subtract from GDP? For that matter how much does one additional death subtract? If we ask what is the loss when a lake becomes eutrophic we at least have the market price of fish as a guide, but many decisions on environment involve the incommensurables of lives versus dollars<sup>2</sup>.

Similar observations can be made on overfishing the oceans, draining wetlands, destroying species as tropical forests are exploited.

In short, if we don't know how much a marginal change in emission of carbon dioxide, or a marginal loss of ozone, or other side-effects of industry, cost the economy, how can we calculate what expense we should go to in modifying the economy to avoid

those side-effects? The sophisticated and powerful apparatus of economics seems here to be impotent.

Not so, it will be said. Economics has thought of all these things, dealing with many ecological problems under the head of externalities, and this concept does indeed diagnose the problem. If producers and consumers were somehow prevented from charging to neighbours or the community as a whole any part of the costs of their activities then the incentive to do many of the things that worry ecologists would disappear (collecting the benefits to the community resulting incidentally from one's activities, positive externalities, is out of our scope). So the answer would seem to be the political authority taxing producers and consumers amounts equal to the ecological costs of their activities, and then distributing the funds so collected to those who suffer the side effects of the activity. The principle is correct, and there are indeed examples, in the cleaning up of the Rhine and other rivers, in which it has been applied and found to work.

There are two major practical difficulties, however. If one does not know what the costs of ecological damage are, both over the short and the long run, particularly the costs imposed on later generations, then there is no way of assessing the amount of tax necessary for the offsetting of those costs. More important, the proposal to make government responsible throws the matter into the realm of politics. Economics has (rightly) been warning us for more than two hundred years against trusting government with responsibility for administering the economy. It knows that once a question is thrown into the arena of politics the outcome is unlikely to accord with principles of rationality that are the strength of economics. Adam Smith (1776, book IV, ch. 9) expressed with eloquence this justifiable distrust of government:

"The sovereign is completely discharged from a duty ... for the proper performance of which no human wisdom or knowledge could ever be sufficient: the duty of superintending the industry of private people."

Governments necessarily work on a political calculus. They are not required to take productivity and environment into account, though they are required to pretend to do so. Yet the matters that fall under the heading "protection of the environment" are especially sensitive politically, as we know in the United States from the effort to tax gasoline even at the trifling (compared with Europe) amount of 7 cents a gallon. And it is precisely on these matters where government is least competent to devise and execute policy that the concept of externalities would nominate governments to take responsibility. We have no right to think it would be more efficient here than it has been at price fixing or curing unemployment. We know among other things that when officials are appointed to control economic agents they are too often captured by those agents. And all this is especially true when there is disagreement on the extent of the danger or what to do about it.

Beyond all these difficulties at the national level, many of the most important externalities extend across international boundaries. That applies to pollution in international rivers, to fisheries on the high seas, to transboundary air pollution. If national governments have difficulty handling such matters within their own countries, think of the difficulties facing international authorities, with their extremely limited ability to mandate anything or to penalize violations. I have no alternative proposal, but

suggest that we need study in both the economics and the politics of environment and natural resources, all carried out with due respect for the biology involved.

## **8. The Danger of Utopias Based on Politics Alone**

Few will disagree on the impracticality of an ecological utopia that consists in going back to the hunting and gathering stage, before agriculture transformed the ecological setting of mankind. But a political utopia has seemed practical enough to attract good minds to its support over the past century or more, yet in the end its last form, communism, turned out to be very nearly as impractical as going back to the pre-neolithic. Some said that if we had a single agency entrusted with both production and responsibility for the environment, and free from the pressure of competition or the need to make a profit it would choose production methods that did the least damage and otherwise could reconcile its two functions. It also had a third related function: it was the agency that collected and disseminated information, including statistics, on both economic and ecological questions. In the utopian view, it would orient its statistical collections to bringing bad conditions to public attention, so that it would secure general support in dealing with them promptly and effectively.

Something must be wrong with this logic, as we see now that the USSR is dissolved and its methods exposed to view. The advantage of a single authority in all three domains--economic, environmental, and informational--is more than offset by the disadvantage of such an agency having constant preoccupation with its own self-protection, its perpetual seeking of short-term objectives and concealing statistics that might reveal the long-term and hidden costs of what it is doing. Georgei Golitsyn, a distinguished Russian atmospheric physicist, tells some of what went on in the USSR when the whole country was under a single manager:

"... people lacked real responsibility for the environmental, and very often the economic, consequences of their actions...the manufacturers were interested only in a quantitative increase in production, not in qualitative improvement....The uniqueness of a plant producing a particular item ... makes it impossible to close the plant in the event of it causing an ecological hazard, even for a relatively short period of time...the amount of intermediate products produced per final product is about 2.5 times larger than in developed countries [a measure of waste in production (Golitsyn, 1992:125)]."

This is not to be taken as a warning against communism alone. It is a warning against consolidating economic, ecological, and political authority, against a single political authority that will deal with everything. We have certainly not reached the end of history, as has been erroneously asserted, but we have probably reached the end of a series of political utopias extending back into the 16th century.

## **9. The Drive for 'Justice' That is Rocking Many of the LDCs**

The center-right and center-left governments of Europe have on the whole promoted economic rationality (for instance on tariffs and immigration) and in this are leaving their electorates behind. Italy has other problems, but it is still worth noting that in the recent

election the far left and the far right gained at the expense of the center, and this is in line with the tendency of recent elections throughout Europe. The French farmers have shown how violent can be the reaction to the widening of markets. We intellectuals mostly do not approve of violence, but must concede that the threat of it is as real a fact as the increase of production that will follow from the wider market. However it is in some of the LDCs that the drive for "justice" is outlined most sharply.

The demand for equity in the rich countries expresses itself in the form of restlessness in the face of unemployment. Developing countries cannot afford unemployment in the German style; people have to find something to do or go hungry. They may live with relatives; they may beg on the streets; they may sort through garbage. But the fact that unemployment is hidden, not officially recognized or compensated, not even measurable, does not make it easier to bear. For many developing countries our press reports violent protest against the liberal order. Those excluded from the economy turn to one extremism or another. Iran, Algeria, Egypt, Indonesia, listed in order of the number of incidents manifesting fundamentalism as reported in the press, show the trend. Other countries are not far behind these.

The watchword of the excluded is "justice", by which they mean equity and participation in society. Of all the elements that constitute 'participation' none is more important than a job at the level of one's training and ability. And that is what is desperately lacking in many of the developing countries, even in some that are rapidly increasing in average income.

It is worth looking at the revolution that took place in Iran in 1979, since one fears that it shows a path that some other countries could well follow.

## **10. Response to Progress Without Equity: The Case of Iran**

Among the countries that made what looked like real progress was Iran under the Shah. Let us disregard here the democracy and human rights sides of the Shah's regime, for the new rulers who brought him down are even less attentive to these issues. The Shah went excessively for import substitution, now seen as the wrong path, but again we do not blame him for following what was the fashion of his time.

His economic policies seemed on the whole to be accepted internally and approved by outside observers. Says one of these, writing just after the crash but before its significance was understood, and approvingly describing the policies of the Shah's regime:

" the goal of using oil to build a self-sustaining economic structure, which is set out in the Third, Fourth, and Fifth Development Plans, has been espoused by successive governments and by contending political groups" (Lieberman, 1979).

This was written some months after the Shah had been deposed, and the new regime, under the Ayatollah Khomeini, had taken over the reins of government, a good time to survey the gains of the Shah's regime. Lieberman continued:

" Iran now produces a wide range of consumer durables and non-durables, along with certain...capital goods. Progress has been noteworthy in the production of textiles, shoes, vehicles, tyres, and electrical machinery for industrial and non-

industrial use. The integrated iron and steel mill in Isfahan, a heavy machine tool plant and an aluminium smelting plant in Arak, the tractor factory in Tabriz...."

And the social side was not wholly neglected:

"gains in the literacy, health, and security of the population, and specifically in the status and well-being of women should be noted."

What LDC would not envy these achievements, admittedly due to oil but with excellent prospects that before oil deposits were exhausted the economy would have taken off.

Lieberman thought that some small changes might take place under the new regime, especially in the direction of more support for small farming, but on the whole he took for granted that the main track established by the Shah, his rational and enlightened guidance of the economy towards greater and greater wealth, would be followed. Religion would not be discarded, but it would be confined to its own separate domain. No need here to recount how wrong that has proven to be; Islamic fundamentalism is thoroughly established, and if there is any movement in prospect it is towards application of more extreme measures of Islamic law. We read currently about conflict of aims: fundamentalism versus contact with Europe and America, but up to now it is the former that dominates.

That Iran should be among the first countries to have fallen off the development track is especially remarkable given that its economy has been one of the most successful. By 1980 it had attained an income per capita of over \$2000 current dollars, as against \$380 in 1970. During the same decade its population grew from 28 to 38 million. It is true that its elite took a considerable share of the benefits of development, but much of what the elite took was in turn invested in development projects.

It has not been easy to secure detailed figures on Iran for the recent period, that has been complicated by the Iran-Iraq war, but clearly there has been a reversion back to small-scale farming, continuation of industry as far as the Shah took it, but little disposition to continue the expansion.

## 11. Other Countries may be Following Iran

Algeria's income per capita is not very different from Iran's and it would have followed Iran and substituted another ideology from that of development by now if it was not restrained by a firm government willing to suspend democratic institutions. That government called off an election in 1992 that the fundamentalists would certainly have won, and it has put many of the opposition leaders in jail. Such measures disappointed Western governments, or so they professed; one is not sure whether it was the firm action or the need to take firm action that they were really protesting about. The Algerian public largely opposes the drastic measures taken, but so far the current regime remains in the saddle. Says *L'Express* (Feb. 17, 1994:19) in a special section devoted to Algeria:

"The great majority of Algerians has no illusions left; the Islamists will sooner or later take power...The present regime [say some, not even very pious] is like a tick that sucks blood--it should be torn out."

Indonesia is not as well off as either Iran or Algeria, with an income per capita that at its peak reached \$610 current dollars per capita (1983), and yet it too has been making great progress in recent years in building export industries that ultimately would replace its oil. It is under considerable pressure from the fundamentalists. *The Economist* (Mar. 13, 1993:65) comments on

"the country [being] 88 per cent Muslim--and increasingly conscious of the fact."

Some observers fear that the non-ideological and more or less secular leaders now in charge will have to apply increasing force if they are to prevent the country from falling off the development track as Iran has done and Algeria would have done if its democracy had not been suspended. A sign of what may be coming is the effective demotion of the economic leaders who have brought Indonesia to its present promising condition based on its low-cost labor, and their replacement at the centre of power by proponents of highly capitalized industries, starting with aircraft manufactures. Shifting from textiles to aircraft does not correspond to Indonesia's relative advantage, but it does correspond to national pride.

Egypt has only relatively small oil resources, and so its economic prospects are not the same as those of Iran, Algeria, and Indonesia, but nonetheless it is subject to some of the same political pressures.

## 12. Fundamentalism

The question for us here is whether such phenomena are part of the reality that social science should take account of? The economist sincerely considers that he has given his answer--that development is a matter of investment, of human capital, and other variables within the discipline of economics, and if fundamentalism enters, and the terrorism that it justifies, that is sheer irrationality that no scholar can be expected to deal with. Yet we bear in mind that science deals even with schizophrenia and the mental processes of chimpanzees, which are more extreme manifestations of irrationality than fundamentalism.

Fundamentalisms have been the subject of a major research project sponsored by the American Academy of Arts and Sciences and based in the University of Chicago's Divinity School under Martin Marty. It is providing a better understanding of "why they have sprung up with such force at the end of the 20th century, and what they hope to achieve (*Economist*, Mar. 27 - Apr. 2, 1993:51)."

" The movements...aim either for political power or to change society in some radical respect... All see themselves as 'fighting back', using violence if necessary, against the forces of secularism and modernism. ...Foremost among fundamentalists aspiration is a 'return' to 'family values', with women as mothers and housewives and men as the principal or only breadwinners..."

" Causes of the new religious activism include the collapse of Marxism, the failure of national governments to honor promises made after independence, and the emergence of a world market...Fundamentalist ideologies...stress social justice and the redistribution of wealth (*ibid.*)."

An inner fury is evidently aroused in many parts of the world, poor but evidently not the very poorest, by what they see of development as it is actually taking place. That fury is expressed in politics without civility, in armed uprisings, in retreat to fundamentalisms that provide divine sanction for violent and irrational behavior. Dispensing what will be interpreted by the crowds, say in Algeria, as justice is not easy, for though the authorities have to provide more equity than at present they must not remove individual incentives. And their problem is accentuated by their felt need to make expensive provision for themselves and their families. When equity is lacking the fundamentalists can claim to have justice on their side; when incentives are lacking progress stops.

Expressed or unexpressed, implicit in the discussion of development, is this tension between incentives and equity. In short, incentives that are too strong lead to uprisings of those who cannot compete, complete equality leads to stagnation.

### **13. The Practical Meaning**

I believe I have shown that development, if it is to be permanent, requires not one but three keys, that are held by different disciplines. Without going as far into detail as I would have liked, I have sketched utopias of production, of equality, and of sustainability, and suggested that all three forms are equally unworkable.

That means that elements of all three are required for a system to be workable. If one starts with economics it has to be tempered with provision for equity and for environment, whose secrets are locks that political scientists can open if anyone can. At least one can say that their bafflement is more sophisticated and professional than that of people who do not know the literature of the field. And similarly if one starts with the environment, one must build the system with consideration for the economy and for equity. If economists start to do biology that is a vote of non-confidence in professional biology; if biologists start to do economics they are saying that economists are not doing their job. Such assertions are hardly the way to initiate interdisciplinary study that is necessary in prescribing solutions for real problems.

### **Footnotes**

<sup>1</sup>We are indebted to Allen Kelley for a survey of the oscillations of economic thinking on population (See Kelley, 1993).

<sup>2</sup>Though heroic and highly commendable efforts have been made to infer how society values incommensurables. The International Institute for Applied Systems Analysis (IIASA) has been a leader in this work, especially in the writings of Joanne Linnerooth-Bayer.

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## CHAPTER 4

# PRESSION DES POPULATIONS HUMAINES SUR L'ENVIRONNEMENT: ASPECTS DEMOGRAPHIQUES DANS LES PAYS OCCIDENTAUX

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### 1. Un environnement pour qui ?

Peut-on parler d'environnement en faisant abstraction de la population humaine ? Le terme environnement semble par moment avoir été amputé de son qualificatif humain alors que c'est par rapport à la population humaine que la notion d'environnement prend toute sa dimension. En effet, l'intérêt que nous portons à l'environnement n'a de sens que dans son interaction avec l'homme.

De tout temps, la nature, dans sa globalité, a été marquée par des équilibres qui nous apparaissent *a posteriori* comme immuables. En fait, ces équilibres sont au sens des équilibres écologiques, des équilibres cycliques (Lamotte, 1985:149-52) que seules pouvaient perturber les catastrophes naturelles telles que volcaniques ou d'ordre stellaire (météorites...). Telle est brièvement la situation au moment de l'apparition des primates et de l'homme. En se distinguant progressivement de l'ensemble du règne végétal et animal, les primates (Moscovici, 1976) et, plus encore, par la suite, l'homme, ont introduit un élément perturbateur dans un équilibre à évolution tendancielle lente.

Ainsi, l'homme a introduit le feu, organisé l'élevage et l'agriculture, utilisé la force de l'eau, exploité les minerais et autres ressources naturelles. De la sorte, au fil du temps, l'impact de l'homme, devenu élément perturbateur (au sens où il perturbe l'évolution habituelle de la nature), s'est accru de façon considérable et deux facteurs rendent compte, de façon complémentaire, de cette augmentation qui a pris une allure quasi-exponentielle:

- l'accroissement exponentiel du nombre des hommes peuplant la planète;
- l'évolution de son comportement qui a tendance à modifier de plus en plus intensément le cours normal de la nature notamment par l'introduction de techniques toujours plus agressives vis-à-vis de l'environnement.

L'impact de l'homme sur son environnement est d'autant plus évident dans les régions de vieille industrialisation dont les paysages ont été largement travaillés par la main de l'homme. Nous avons donc hérité d'un environnement naturel soit, mais déjà transformé. Les modifications se sont intensifiées dès le XIII<sup>e</sup> siècle avec le défrichage intensif de la forêt qualifiée à l'époque d'impénétrable, l'extraction du fer et de la houille et l'urbanisation galopante soutenue par l'industrialisation sauvage renforcent encore ce processus agressif.

Notre environnement est le résultat d'activités successives de l'homme qui s'est approprié l'espace (et ses ressources naturelles) avec comme objectif prioritaire, celui de **survivre**. Le lien entre croissance démographique et apparition de techniques nouvelles est évident. Aussi les déboisements massifs du Moyen-Âge ont eu un impact sur l'environnement naturel aussi bien par une augmentation manifeste du nombre des hommes que par le recours concomitant à des techniques nouvelles qui se sont avérées plus agressives pour le milieu naturel. Toutefois, il est fort probable que ces changements intervenus au Moyen-Âge aient été perçus uniquement comme éléments majeurs d'une stratégie de survie et non comme une atteinte à l'environnement naturel et une dégradation de celui-ci. Le contexte de la révolution industrielle au XIX<sup>e</sup> siècle est assez similaire puisqu'on y retrouve la croissance démographique, la volonté de survivre, l'introduction de techniques nouvelles largement plus agressives et une insensibilité assez générale à la dégradation de l'environnement.

C'est en milieu urbain densément peuplé que le concept de dégradation de l'environnement est apparu en premier lieu, semble-t-il, et a donné lieu à un processus d'assainissement et de déconcentration des centres urbains. Les conséquences néfastes sur la qualité de la vie de la révolution industrielle et de l'urbanisation massive et rapide de certaines contrées n'apparaîtront que très progressivement. Somme toute, la qualité de la vie et la dégradation de l'environnement sont les deux éléments clé de l'interaction entre population et environnement.

Plus récemment, la stratégie de survie a laissé progressivement la place à celle d'un mieux-vivre. Cette nouvelle stratégie fut aussi, dans une première étape, une grande consommatrice d'espace, avant de se tourner, forcée, vers un respect incontournable de l'environnement. L'époque marquée par l'exploitation non réfléchie de la nature et de ses ressources semble révolue, pour le moins dans les pays développés. Une perception nouvelle est apparue, la pensée qu'une limite a été atteinte, s'est faite jour. Dès lors, la nécessité de préserver notre environnement, voire de l'améliorer, est devenue un enjeu de société. On pourrait affirmer que la revalorisation du niveau de bien-être général des populations s'est faite de pair avec une perception plus nette de la qualité de l'environnement. Cette attitude nouvelle est-elle issue d'un caprice de notre génération prospère ou plutôt d'une prise de conscience de responsabilités nouvelles vis-à-vis des générations futures ?

## 2. Quel environnement ?

L'environnement est à la mode, il est conjugué à tous les temps et recouvre des réalités variables. Dans ses travaux, l'Union Européenne envisage l'environnement, de façon large et englobante, comme l'ensemble des éléments qui, dans la complexité de leurs relations, constituent le cadre, le milieu, les conditions de vie pour l'homme. De son côté, le Petit Robert (1991) est plus restrictif et définit l'environnement comme l'ensemble des conditions naturelles (physiques, chimiques, biologiques) et culturelles (sociologiques) susceptibles d'agir sur les organismes vivants et les activités humaines. Enfin, dans certains milieux scientifiques mais également de décideurs politiques, le concept d'environnement est plus restreint encore, en se bornant aux

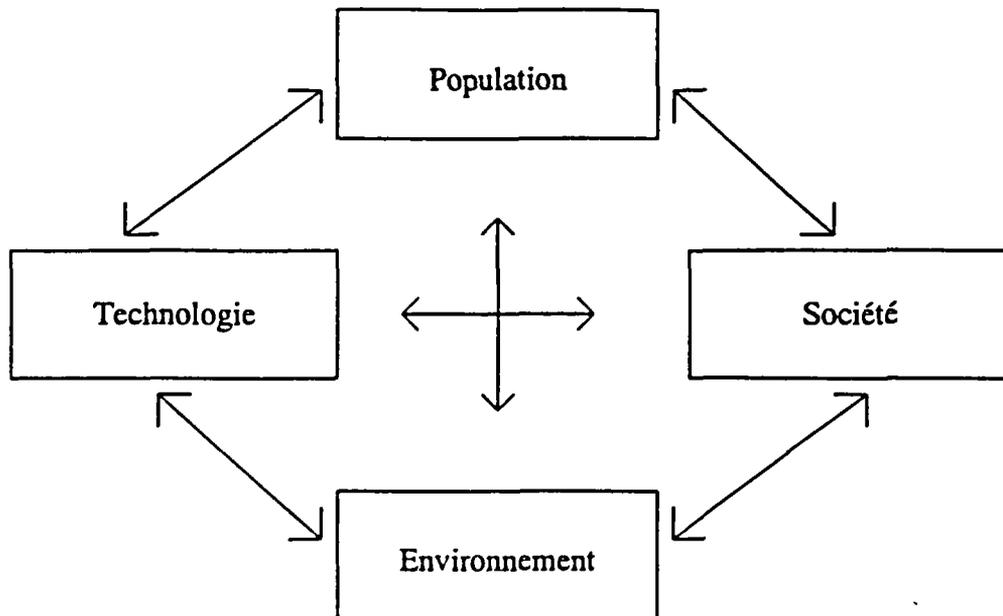
seules interrelations entre les conditions naturelles et les activités humaines. Dans ce domaine, c'est principalement la gestion des ressources naturelles qui monopolise la quasi-totalité des actions. Tel est bien le risque ultime: confiner l'environnement à la seule étude de l'impact des activités humaines sur l'état des ressources naturelles. Cette approche restreinte ne tiendrait pas compte de l'homme si ce n'est dans son apport négatif de pollueur, de consommateur immodéré des ressources naturelles et de destructeur de l'environnement. A l'inverse, il est urgent de traiter le problème en établissant la relation dans les deux sens: l'influence des populations sur l'environnement, d'une part, mais également celle de l'environnement sur les populations, d'autre part. Il est ainsi primordial de rejoindre une "écologie humaine" qui proposerait une approche cohérente et non "réductionniste" des questions d'environnement (Poucet, 1992:23).

Ne perdons pas de vue que l'échelle du niveau d'analyse est également importante et variable selon le problème environnemental traité, en passant de l'individu, à la communauté villageoise, à la région, voire à l'ensemble de la planète, seul niveau où le réchauffement du climat et l'influence de la couche d'ozone se doivent d'être analysés. Lorsque la complexité des analyses sera vaincue par de réelles approches interdisciplinaires dans les études de cas bien définis, mettant en jeu une société et une population précises en interaction avec un écosystème déterminé, l'heure sera venue d'établir des généralisations.

### **3. L'interrelation entre population et environnement: les prémisses d'une réponse à une question en suspens?**

La communauté scientifique s'est penchée ces dernières années sur le problème des interrelations entre population et environnement, mais, à quelques exceptions près, il a été envisagé soit globalement, à l'échelle planétaire, soit dans des cas spécifiques émanant des pays en développement<sup>1</sup>. Dès lors, le cadre conceptuel déployé dans ces approches n'est pas nécessairement le plus approprié pour ce qui regarde notre problématique, celle de l'examen des interrelations "population – environnement", dans nos pays occidentaux.

Nous proposons ci-dessous un schéma conceptuel simple, en accord avec les travaux de Thilgès et Tabutin (1992) et Tabutin (1993) sur les pays du Sud, construit de façon tout à fait générale, et qui peut très bien s'appliquer à la réalité de notre région.



Comme le laisse pressentir ce diagramme, l'interaction entre la population et l'environnement est complexe puisqu'elle est à la fois directe et indirecte. Avant de l'aborder avec plus de précision, il convient de fixer le concept de population.

### **Le concept de population**

Il est utile de préciser ici que nous entendons le concept de population de façon restreinte, strictement démographique, c'est-à-dire en privilégiant les points suivants:

- le nombre des êtres humains en un lieu donné et dans un écosystème précis;
- leurs structures démographiques par sexe, âge et éventuellement par nationalité, état matrimonial...;
- le mouvement de la population par le biais des naissances et des décès, mais également des entrées et sorties du territoire considéré.

Seuls les comportements d'ordre démographique sont pris en compte afin d'expliquer les propensions relatives à la fécondité, mortalité et mobilité spatiale. Les comportements relatifs au respect de l'environnement ne sont considérés que de façon indirecte dans la mesure où ils sont différents d'une sous-population à une autre. Dès lors, toute modification de la structure démographique se traduira par un "comportement moyen" distinct et un impact différent sur l'environnement.

### **L'impact de l'environnement sur la population**

Bien que notre objectif se cantonne dans une mise en évidence des effets des variables démographiques sur l'environnement, on ne peut ignorer l'impact inverse. Ainsi, l'environnement exerce une influence sur la population et ce, de manières diverses. Il existe, tout d'abord, un impact naturel de l'environnement sur les hommes. Le climat dans ses variations extrêmes (sécheresses, inondations, tornades...) (Veyret et Pech, 1993: 135-222) ou sa moyenne (type de climat tempéré ou continental...),

les catastrophes naturelles comme les tremblements de terre mais également des phénomènes telles que l'émission radioactive naturelle.

L'environnement de plus en plus dégradé à la suite des activités humaines exerce à son tour une pression sur les populations humaines, principalement en matière de morbidité et de mortalité, mais également dans le domaine de la fécondité<sup>2</sup> et de la mobilité. Les différents éléments démographiques en seront à leur tour affectés: taille, composantes du mouvement des populations et structures démographiques.

L'historique de la pression de l'environnement sur les populations laisse transparaître le rôle prépondérant du concept de qualité de vie (Poelmans-Kirschen *et al.*, 1973: 18-21) comme médiateur entre environnement et population. On constate bien souvent que les besoins de l'homme sont mis en concurrence: plus il accapare son milieu pour assouvir ses besoins, plus il le détruit et plus sa propre qualité de vie se détériore. Cette chaîne de conséquences arrive même à modifier les comportements de la dynamique démographique. Quand l'espace de vie ne répond plus à l'image que l'homme en attend, d'autres espaces plus conformes aux désirs sont occupés par lui, par le biais de la migration.

#### **4. L'impact de la population sur l'environnement**

Il est très malaisé de parler d'une action directe de la population sur l'environnement car, dans bien des cas, les sphères dénommées "technologie" et "société" jouent un rôle d'intermédiaires et modulent l'impact direct entre population et environnement. Prenons un exemple concret pour illustrer le schéma conceptuel. L'accroissement du nombre d'individus sur un territoire se traduira, à comportement humain constant, par un accroissement similaire des déplacements de la population. L'augmentation du trafic routier, par exemple, entraînera, à technologie également constante, une augmentation de la pollution atmosphérique. Parallèlement, l'apparition de technologies nouvelles pourra se traduire par une diminution de la pollution *per capita* et compenser en quelque sorte, tout ou en partie, l'augmentation due à l'accroissement démographique. En outre, une société pourra faire le choix d'une consommation plus propre et favoriser le recours à ces technologies nouvelles, par le biais d'une législation appropriée. Finalement, l'impact de l'accroissement du nombre d'individus sur l'environnement devra prendre en compte à la fois le rôle des technologies nouvelles et le choix de société visant à favoriser le recours à celles-ci.

**L'impact démographique de la population sur l'environnement est-elle mesurable ?**

Un débat scientifique s'est développé aux États-Unis, il y a plus d'une vingtaine d'années, sur l'estimation de l'impact de la croissance démographique, par rapport à la technologie. Les principaux artisans, Paul Ehrlich et Barry Commoner, se sont querellés par l'intermédiaire d'articles scientifiques (Marden et Hodgson, 1975:37-128) sur le poids de la croissance de la population dans l'augmentation des pollutions. La finalité du débat consiste à évaluer la part du facteur humain et celle du facteur technologique dans la dégradation de l'environnement. Cette querelle vaut la peine de

s'y attarder, car elle est très symptomatique de la difficulté de distinguer et d'estimer l'impact direct de la population sur l'environnement.

De façon synthétique, ce débat se résume comme suit. Paul Ehrlich avance l'idée que la croissance de population est le facteur majeur qui explique la dégradation de l'environnement, alors que Barry Commoner argumente en faveur d'autres variables, principalement technologiques, comme responsables de la pollution.

Selon Ehrlich, depuis que les sociétés humaines sont devenues agricoles et technologiques, chaque être humain a un impact négatif sur l'environnement parce qu'il participe à l'utilisation des ressources, qu'elles soient renouvelables ou non. Dès lors, il établit une relation où  $I$ , l'impact total négatif ou niveau global de pollution correspond au produit de l'effectif de la population,  $P$ , et d'une fonction  $F$  qui mesure cet impact sur l'environnement par tête d'habitant. Cette fonction  $F$  est la résultante des effets technologiques sur l'environnement. Elle inclut, entre autres, l'exploitation des ressources non renouvelables, l'utilisation de technologies non polluantes...

Commoner prolonge cette même idée en introduisant le rôle intermédiaire de la consommation par tête d'habitant à l'aide de la relation suivante:

$$I = P . A . T$$

où  $P$  est la taille de la population,  $A$ , la consommation d'un produit donné par tête d'habitant,  $T$ , la pollution par unité de production de ce produit et  $I$ , le niveau total de pollution ou l'impact négatif sur l'environnement.

Cet auteur établit alors une liste de productions technologiques nuisibles en rapport avec leur consommation par habitant. En établissant une équivalence entre production et consommation, il détermine l'impact total sur l'environnement. Il montre ainsi que, depuis la fin de la seconde guerre, la croissance de la consommation-production par tête d'habitant est la principale responsable de la pollution. Dans un article plus récent, il constate néanmoins que le poids de la population est loin d'être négligeable bien qu'il l'estime comme étant trois fois moindre que celui de la technologie (Commoner, 1988)

Finalement, Ehrlich reprenant également l'équation  $I = P.A.T$ , démontrent l'importance, pour les pays en développement, de réduire la croissance de la population  $P$ , puisqu'elle est le facteur le plus important de l'augmentation de la pollution (Ehrlich et Ehrlich, 1990:57-58)<sup>3</sup>. Par contre, pour les pays développés, l'important, selon lui, est de réduire le facteur  $T$ , la pollution par unité de production, pour chacun des produits de consommation à caractère polluant.

Un exemple chiffré fourni par Commoner (1992:74) permettra de mieux cerner ce type d'approche dans le domaine de l'utilisation d'engrais azotés en agriculture. La question posée est la suivante: *"Quelle est la part de l'accroissement de population, de l'accroissement de consommation par individu et l'évolution de la quantité d'engrais utilisée par unité de production pour rendre compte de l'augmentation de l'utilisation d'engrais azotés en agriculture ?"* Au total, de 1975 à 1986, l'utilisation d'engrais s'est accrue de 9,3% pour l'ensemble de la Belgique et du Luxembourg. Dans le même temps, la population s'est accrue de 0,6%, la production agricole, de 14,3% et l'utilisation d'engrais par unité de production s'est réduite de 5%. Force est de constater que, dans cet exemple précis, la population en tant que variable démographique, joue un rôle négligeable. L'augmentation de la pollution des sols

cultivés résultant de l'utilisation d'engrais azotés y est essentiellement due à l'accroissement de la consommation, accroissement en partie compensé par des progrès biotechnologiques (réduction de la quantité d'engrais azotés nécessaires par unité produite).

Cette approche nous paraît simpliste et étonnement réductrice. Personne ne nous convaincra qu'il est désormais possible de faire la part des choses entre ce qui est dû à la variable "population" et ce qui ne l'est pas, car les mécanismes en cause sont manifestement plus complexes. Même en étendant cette approche à d'autres types de production et de pollution, il semble impossible, de façon sûre, de délimiter le partage des responsabilités entre l'évolution de la population, celle de la consommation et celle des progrès technologiques. Isoler l'effet "pur" de la variable "population" reste, selon nous, du domaine du mythe scientifique.

### **Les concepts de capacité de charge et de densité de population**

La littérature scientifique propose également une mesure de la pression démographique sur l'environnement par le biais du concept de la capacité de charge, ou carrying capacity (Smith, 1976:58-60, 74-6) en anglais. Initialement, cette notion a été introduite par les agronomes qui souhaitaient déterminer la taille maximale de la population que pouvaient nourrir les ressources agricoles potentielles d'une zone donnée. Cette notion débouche sur celle de densité démographique maximale, qui, de façon théorique, se base exclusivement sur les besoins alimentaires des populations. Elle est d'application uniquement pour les sociétés traditionnelles vivant en autarcie agricole sur un territoire bien délimité. Ce concept est caduque pour nos sociétés, car la potentialité productive de l'écosystème et les méthodes agricoles ne sont pas seules à influencer la densité du peuplement. De nos jours, les systèmes politiques en place et le type d'échanges commerciaux, dans un marché économique à dimension planétaire, importent largement plus.

Dans le cadre des travaux du Club de Rome, ce concept a été élargi pour inclure la consommation énergétique quotidienne liée à tous les aspects de la vie humaine: alimentation, chauffage, transport, consommation de produits industriels (Delaunay, 1972). En outre, le concept de carrying capacity inclut une comptabilité des phénomènes écologiques tels que la dégradation de l'environnement et l'épuisement des ressources naturelles. Ce nouveau type d'approche cherche à déterminer quelles sont les limites physiques et démographiques au développement durable d'une société, sur un territoire donné. Ainsi, on aboutit à un concept plus approprié pour notre propos et plus adéquat pour appréhender les interactions entre population et environnement: la capacité de charge démographique. C'est le seuil démographique de rupture d'une société face à son environnement sur un territoire donné, ce seuil démographique n'étant pas fixé uniquement en terme de nombre d'individus, mais également en tenant compte des structures de la population.

Ainsi, devant l'impossibilité de déterminer cette capacité de charge, on se tourne généralement vers la notion de densité de population. Néanmoins, la densité telle que calculée en habitants au kilomètre carré est une pauvre mesure de la pression démographique. Les populations humaines comme les populations de plantes ou d'animaux, n'occupent pas tout l'espace géographique puisque celui-ci n'est pas

entièrement disponible à l'implantation humaine (cours d'eau et dénivellation trop importante...). De plus, l'entité spatiale de référence cache souvent des disparités importantes au sein de son territoire, des zones urbaines côtoyant des espaces agricoles. La densité est-elle dès lors un indicateur efficace de mesure de la pression démographique ?

## 5. L'effet de la densité de population ou celui de la croissance démographique ?

La densité de peuplement dont il vient d'être question a-t-elle une influence sur l'environnement ? Et si l'on considère que les fortes densités ont une influence négative, cette question laisse place à la suivante: l'environnement urbain est-il plus sensible à la dégradation que celui des campagnes ? Dans la perspective historique, la qualité de vie urbaine a toujours connu des difficultés même si elle s'est considérablement améliorée au cours du dernier siècle. Une forte densité de peuplement humain induit *ipso facto* la présence d'industries de production énergétique, mais également d'autres industries productives situées traditionnellement à proximité des grands centres de peuplement, pourvoyeurs de main-d'oeuvre. Aussi, la pollution industrielle est-elle indissociable de la pression susceptible d'être attribuée aux hautes densités de peuplement.

Plus spécifiquement, quel est l'impact d'une forte densité d'êtres humains, de par leur activités domestiques et leur vie de tous les jours ? C'est la pollution atmosphérique par le chauffage domestique et le gaz d'échappement des véhicules automobiles qui, la première, vient à l'esprit. Actuellement, la pollution de l'air due au trafic routier dépasse largement celle provenant du chauffage domestique et constitue la première cause de la concentration de la pollution en milieu urbain. L'environnement urbain souffre également de la pollution des eaux des ruisseaux traversant les villes et devant accueillir un volume d'eaux usées en relation avec le chiffre de la population. De même, l'élimination des déchets ménagers est une tâche dont l'ampleur s'accroît, au même titre que les risques de pollution qui en résultent, avec la densité de peuplement. Par ailleurs, le bruit constitue également une pollution urbaine qui affecte la qualité de la vie et indirectement la santé. Globalement, nous pouvons supposer, en toute première analyse, que l'intensité de ces pollutions est en relation directe avec la densité de peuplement.

Bien que ce point se trouve à la marge de notre approche, on ne peut ignorer qu'il existe, dans les centres urbains, beaucoup plus qu'ailleurs, des besoins urgents de réaménagement de friches abandonnées, de quartiers délabrés, en vue de promouvoir une certaine esthétique urbaine indispensable à la qualité de l'environnement urbain. Ce type de dégradation de l'environnement est également associé à la densité de peuplement, mais il doit être rattaché, plus encore que les autres, à un ensemble de comportements humains qui peuvent être favorisés ou enfreints par les incitations des pouvoirs locaux.

L'hypothèse selon laquelle le risque de dégradation de l'environnement urbain, notamment de la qualité de l'air, de celle de l'eau et de tout ce qui touche à la gestion des déchets, serait proportionnelle à la densité de peuplement est faite en l'absence de recours à des techniques plus appropriées à de fortes densités de population et de

consommateurs. Or, il ne fait aucun doute que les investissements technologiques tels que les transports en commun à énergie électrique, les murs antibruits, les systèmes de contrôle de la qualité de l'air etc. sont généralement orientés, de façon prioritaire, vers les zones critiques à haute densité de peuplement. En outre, la préoccupation des gestionnaires locaux est vraisemblablement plus sensible aux problèmes d'environnement, de telle sorte que l'action politique en la matière pourrait très bien effacer, tout ou en partie, cet impact négatif de la densité de peuplement sur l'état de l'environnement urbain.

Qui plus est, la perception du respect de l'environnement varie selon l'âge et le sexe des intéressés, mais également selon le milieu urbain ou rural (Collomb et Guérin-Pace, 1993 et 1994) Il en résulte souvent une prise de conscience de la population plus forte en milieu de haute densité, avec, pour conséquence, l'apparition de courants d'opinions et de comportements plus favorables au respect de l'environnement. Somme toute, dans la plupart des pays occidentaux, on masque partiellement ce que nous supposons, dans un premier temps, être une proportionnalité entre densité de peuplement et risque de dégradation de l'environnement. Même si l'on pressent qu'une intensité du peuplement plus élevée peut se traduire par une pression plus forte sur l'environnement, la densité de population ne constitue qu'un indicateur assez imparfait pour quantifier cet impact: la variable "population" n'est qu'une variable parmi tant d'autres à prendre en compte pour analyser ce système complexe qui caractérise l'environnement urbain.

Ainsi, la densité de population ne constitue qu'un indicateur assez imparfait si l'on désire traduire la pression démographique sur l'environnement d'un territoire donné. Qu'en est-il de la croissance démographique ? Même si le débat reste ouvert quant à savoir si la croissance démographique considérée globalement, en tant que telle, a un impact direct ou indirect sur l'environnement, il est indéniable que les mouvements migratoires lorsqu'ils sont importants, sont également conséquents et se traduisent clairement par un tel effet. De nombreuses situations observées au niveau local, dans les pays occidentaux, démontrent qu'une forte croissance due principalement aux courants migratoires peut donner lieu à une dégradation substantielle de l'environnement.

Ainsi la croissance démographique, par suite des mouvements migratoires, intervient au moins autant que le niveau de densité de peuplement pour rendre compte de la dégradation de l'environnement en un écosystème donné.

## **6. La pression sur l'environnement exercée par les différentes composantes du mouvement de la population**

Si la croissance naturelle des populations dans les pays industrialisés, l'excédent de naissances sur les décès, n'a vraisemblablement, de nos jours, aucun impact sur l'état de l'environnement, on se doit toutefois d'examiner l'effet potentiel des mouvements migratoires lorsque ceux-ci sont importants et conséquents. En effet, les taux de migration positifs augmentent la pression de la population là où, bien souvent, la richesse de cet environnement est perçue comme un attrait. Les espaces moins peuplés sont, en général, privilégiés dans le choix d'un nouveau logement. Seuls les jeunes de 15 à 24 ans se tournent plus volontiers vers les zones urbaines. Les

personnes âgées de 25 à 39 ans s'installent de préférence dans les régions rurales en frange des métropoles alors que les personnes plus âgées auront tendance à se diriger vers des endroits de villégiature plus lointains.

Dans de nombreuses zones rurales, une arrivée massive de nouveaux résidents peut exercer une pression démographique sur des écosystèmes restés, sociologiquement parlant, traditionnels. Des nouveaux bâtiments, de plus en plus nombreux sont érigés en milieu rural, de nouveaux lotissements empiètent sur les terres agricoles et les habitats naturels, en augmentant démesurément l'espace occupé par les activités humaines. Ces tendances récentes se perçoivent rapidement en analysant l'évolution de la superficie bâtie ou plus généralement l'espace occupé par l'homme à l'exclusion de celui réservé aux activités agricoles et forestières. La croissance démographique dans ces régions pourrait, tout autant, avoir un effet sur les infrastructures d'assainissement et d'élimination des déchets et, dans certains cas, elle posera des problèmes de pollution des cours d'eau et d'accroissement significatif du niveau de bruit. En même temps, la pression urbanistique sur les régions rurales pourrait entraîner, d'une part, une perturbation des activités agricoles par le biais de mécanismes d'érosion et de détérioration de sols productifs et, d'autre part, une modification de biodiversité liée à une utilisation différente des espaces naturels.

L'environnement, sous ses formes diverses, est susceptible d'être affecté par suite de la modification rapide de la taille de la population et de la difficulté d'adapter des situations et des mécanismes agissant, de façon équilibrée, depuis des décennies. En revanche, le phénomène inverse est tout à fait plausible, car les nouveaux arrivés sont probablement nettement plus sensibilisés à la protection d'un certain type d'environnement auquel ils ont été attentifs en choisissant de venir résider à la campagne. Le rôle moteur que peuvent être amenés à jouer, au sein des collectivités locales, certains nouveaux arrivants par l'apport d'idées neuves et d'un dynamisme actif peut orienter les choix pris par la communauté locale. Dans ce contexte, les risques nouveaux de pollution peuvent être maîtrisés au même titre que certaines situations plus anciennes que l'immobilisme des anciens ne cherchait pas à résoudre. Dans ce cas de figure, l'effet des mouvements migratoires deviendra largement positif, nous empêchant de la sorte toute généralisation en la matière. Seule une démarche scientifique articulée sur la base d'enquête et d'analyse de cas concrets serait à même de faire progresser la question.

La pression sur l'environnement fait intervenir le nombre d'êtres humains sur un territoire donné et leur type de comportement, le tout étant intégré dans un contexte socio-économique réglé par des choix de société. De là, vient la difficulté de mesurer quantitativement l'impact de la pression démographique puisqu'elle intervient sur l'environnement, conjointement avec d'autres facteurs dont il est difficile d'évaluer la part. Certes, la croissance démographique, par suite des mouvements migratoires, et le niveau élevé de densité de peuplement doivent être considérés pour rendre compte du risque potentiel de dégradation de l'environnement en un écosystème donné. Mais, l'interrelation entre population et environnement est un problème que l'on ne peut isoler de façon expérimentale telle qu'on la pratique couramment dans les sciences exactes. Ici, certains mécanismes physico-chimiques interviennent au même titre que le comportement humain, le choix sociétal et le système économique de production et consommation. Dans une complexité telle qu'il eut été illusoire d'envisager de la

décrire ici, il convient d'admettre que la variable "population" au sens démographique du terme joue un impact sur l'état de l'environnement qu'il est impossible d'isoler.

## **7. Quel rôle pour les démographes dans le débat "population-environnement" ?**

Après ce tour d'horizon, bien loin d'être exhaustif, du rôle de la variable "population" sur l'environnement dans les pays occidentaux, il est utile de se poser la question de la tâche que les démographes sont amenés à jouer dans ce débat scientifique. Il serait illusoire de croire que ce rôle soit fondamental et que, par conséquent, rien ne se fera sans cette intervention. Bien des approches développées par les chercheurs des sciences exactes incluent la variable "population" dans leurs modèles, sans se soucier le plus souvent de ce qu'en pensent les démographes. Il serait malsain de réagir à cet état de fait par le développement d'approches où la variable population serait l'articulation centrale, en introduisant de nombreux indices caractérisant la qualité de l'environnement et parmi lesquels, nous aurions tout l'embaras du choix et la difficulté de l'interprétation. La seule façon de progresser dans cette recherche consiste en une approche **interdisciplinaire**, au sein de laquelle, ayons l'humilité de le reconnaître, les démographes ne maîtrisent, tant bien que mal, qu'une seule variable. Certes, elle est fondamentale, mais, pour les écologues des sciences exactes traitant la question depuis de nombreuses années déjà, la tentation est grande de simplifier le rôle de la variable "population", sans se soucier de tout l'apport spécifique de la démographie. Une insertion dans un débat qui prend, de nos jours, une importance considérable, ne se fera que si nous faisons l'effort de simplifier les langages spécifiques et de rendre plus accessible la compréhension des théories et des modèles démographiques. S'intéresser à la relation entre population et environnement pour un démographe implique sans conteste l'obligation de vouloir une interdisciplinarité vraie et non déguisée.

### **Notes**

<sup>1</sup>Voyez à ce sujet les travaux de la Commission "Population et Environnement" de l'Union pour l'Etude Scientifique de la Population (UIESP, Liège) et du Comité International des Centres de Recherche en Démographie (CICRED, Paris) ainsi que les recherches de Wolfgang Lutz (IIASA, Autriche).

<sup>2</sup>Une émission de la télévision francophone du Canada (Radio Canada), Télé Journal mentionnait le 17 février 1994 que la fertilité des hommes dans certaines zones autour des grands lacs américains s'était réduite de façon importante depuis une quarantaine d'années. Le facteur incriminé serait un élément chimique présent dans les rejets industriels.

<sup>3</sup>Ce débat est repris pour le cas de CO<sub>2</sub> dans Bartiaux et Van Ypersele (1993).

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## CHAPTER 5

# THE RELATIONS BETWEEN POPULATION AND ENVIRONMENT IN THE CONTEXT OF ECONOMIC GLOBALIZATION: PRELIMINARY CONSIDERATIONS

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### 1. Introduction

Population issues have rapidly become a major theme in the global environmental agenda. During the UNCED-92 Conference, for instance, the world's media networks gave considerable coverage to the presumed role of demographic growth in environmental degradation. Meanwhile, participants in the parallel events of the Global Forum hotly debated population-related topics. This contrasted sharply with the official discussions, wherein the scant and diplomatically-worded consideration given to population matters actually attested to the intensity of emotion on the topic.

Increased attention, however, has failed to generate consensus. Indeed, population/environment (P/E) issues are fraught with controversy and the debate, as has been observed, sheds more heat than light. Hence, despite the real significance of population matters in the context of development/environment problems, intense debate on population issues often ends up retarding objective analysis and discussion of more complicated and transcendental politico-economic dilemmas.

This is unfortunate since environmental problems are, by general consensus, becoming increasingly urgent. The role of population in the gestation or aggravation of environmental problems needs to be spelt out more clearly. Real issues need to be identified and artificial ones discarded.

In the interests of contributing to such clarification, this paper addresses four inter-related questions. First, it will provide a brief but critical review of the main schools of thought in the current P/E debate. Without purporting to cover systematically the vast literature generated by this debate in recent years – and much less over the last two hundred years – it focuses on the main and common limitations of both the alarmist and revisionist schools.

Second, an attempt will be made to proffer a more discriminating framework for the identification of conditions under which given types of population dynamics generate critical environmental consequences. To this purpose, the paper will submit a preliminary typology of environmental problems according to their magnitude and degree of criticality; this will be used to help determine more precisely the manner and form of population impacts on the environment.

Third, the paper will argue that the more significant P/E interactions must be analyzed in terms of the current development scenario; more specifically, P/E has to be

examined in the light of ongoing economic growth efforts throughout the world. In the present historical moment, this means that significant P/E interactions must be examined within the framework of ongoing economic globalization.

Finally, the argument will be made that placing P/E relations appropriately within the context of current development efforts – and therefore of economic globalization trends – shifts the locus of environmental concern in population studies to a greater emphasis on urban-related issues. That is, the prevailing emphasis on rural-related preservation and on primary sector activities should be complemented, in this perspective, by a more encompassing concern with densely populated urban areas.

## **2. The Limitations of the Present Debate on P/E**

Several recent overviews have provided a balanced perspective of different aspects in the P/E relation (e.g. Bongaarts, 1993; Cassen, 1993; Tabah, 1991; Harrison, 1992; McNicoll, 1992; Shaw, 1989; Hogan, 1992; Lutz, 1994; Teitelbaum and Winter, 1993). Whatever their starting points and theoretical basis, it is generally acknowledged that P/E interactions are but one facet of a broader set of issues involving population, environment and development.

Although the connection of P/E with development is seen as crucial by all sides, the interpretations of development's role and manner of impact on this relation vary greatly. Moreover, the more influential schools in this debate generally fail to take into consideration the specificities of development in the present historical scenario and how they will affect P/E interactions. In particular, they fail to consider the political economics of the current development context and how the latter influences population's impact on environmental outcomes.

Efforts at advancing the comprehension of P/E interfaces are largely bogged down in the ideological/disciplinary debate between "limitationists" and "expansionists". Although both camps have a variety of defendants and postures, the following discussion focuses on the two more visible sub-schools – which we can simplistically refer to as "alarmist biologists" and "revisionist economists". Brief reference to this debate is useful as background for the suggestion of an alternative approach.

### **2.1 The Alarmist Biologists**

A sizeable segment of the literature on population and environment during the last 25 years has taken the ubiquitous  $I = PAT$  equation (Environmental Impact = Population x Affluence x Technology) as a starting point for discussion. This equation was initially formulated in 1971 by Ehrlich and Holdren; at the time, it substituted an earlier formula ( $I = P \times F$ ), wherein  $F$  represented a somewhat vague function of "per capita impact"<sup>1</sup>.

Both expressions were coined in the context of a widely-publicized debate which these authors were waging with another noted biologist, Barry Commoner. The latter had been arguing that "pollution" had little relation with either population or consumption; instead, it was determined by the pattern of economic growth – which, in turn, was mediated mainly by technology (Commoner, Corr and Stamler, 1971; Commoner, 1972). The IPAT formulation correctly intended to move the debate away from concern

with pollution to that with more widespread environmental impacts. Moreover, it wished to emphasize the fact that it is necessary to deal *simultaneously* with overpopulation, excessive affluence and faulty technology<sup>2</sup>.

Although originally intended to be little more than the centerpiece of a rejoinder in a heated debate with a rival biologist, the IPAT formulation has survived the ensuing years; indeed, it has appeared as the obligatory starting point for much of the P/E debate.

This formula is undoubtedly a useful tool for calling the layman's attention to some of the key factors in the P/E relation, but like the simplistic formulation which it criticized, it also belies the underlying political and socioeconomic complexities of the question.

In recent years, several reviewers have been increasingly critical of the IPAT formula and its derivatives (e.g. Shaw, 1992; Stern, 1993; Bartiaux and van Ypersele, 1993; Lutz, 1994). Criticism is directed to its interpretation of statistical association as causation, to the frequent use of incorrect aggregations and to the linear extrapolation of trends in the projection of population, environment and development trends; therein, for instance, the responsibilities of poor and rich people are lumped together in sweeping generalizations; meanwhile, technology and per capita consumption are assumed to be uniformly distributed throughout the world. Moreover, despite the authors' statements that the factors are causally interrelated, the equation treats population as a simple aggregate quantity, whose evolution is independent of "Affluence" or "Technology".

More importantly, from this paper's standpoint, the IPAT formulation overlooks the fact that all of the elements in that equation themselves depend on a much more complex constellation of social, political, economic and institutional factors. Thus, it gives little regard to historical conditions or to the extreme variability of social groups. Inevitably omitted in such formulations are exactly those elements which make the subject matter of social scientists so variable, irrational, imprecise and unpredictable – differences in aspirations, values, norms, folkways, behavior patterns and culture; adaptability of human populations to changing circumstances; variations in social structure, political organization, land tenure, social stratification and income distribution; conflicts of interest, ignorance, greed, lust and diverse forms of anti-social behavior; political conduct, manipulation, struggles for power, and so forth.

The same criticism can be levelled at the synthetic formulations of Barry Commoner, the IPAT formulators' arch-rival<sup>3</sup>. In short, synthetic formulations such as IPAT invite us to think of P/E in mechanistic and a historical terms. Although cognizant that each factor in the equation hides considerable complexity, the attempt at synthesis oversimplifies the issue<sup>4</sup>. Coined by natural scientists, IPAT has an aura which emulates their heralded precision but reduces complex social phenomena to oversimplified relations on a limited gamut of poorly-defined variables.

The inability to situate "Affluence" and "Technology" within the context of their socio-political and economic framework helps set up the relatively straightforward "Population" variable as the obvious culprit of "Impact". By the same token, the relative simplicity of "Population" solutions is enticing, particularly in comparison to the complexities involved in dealing with the other factors in the IPAT equation. Attempts to deal effectively with the determinants of "Affluence" and "Technology" would require addressing extremely complex, diffuse and politically-loaded issues; the very nature of

modern civilization would probably have to be brought into question. By comparison, efforts to change irrational and obsolete reproductive patterns are obviously much simpler.

In reaction to criticisms, subsequent writings of Ehrlich and others have attempted to account for the complexity of interactions and variations which influence the way man pressures the environment. Holdren (1991:5-6), for instance, has acknowledged that the IPAT formulation should be upgraded by adding on other variables such as culture, political factors, urbanization and other "causative and modulating factors". However, in doing so, the IPAT equation would lose its appealing simplicity and risk becoming a multi-syllabic oxymoron. The way in which it is suggested that such complexities should be handled is typical of a natural sciences' approach: Holdren (1991:4-5) suggests that we should begin by cataloguing and integrating our understanding of these other "threats to ecosystem services". Amassing more and better evidence on how mankind endangers the environment is thus seen as the key element in any future research agenda.

Such an approach evidently ignores the fact that each of these factors is itself interlinked with more encompassing political, socio-economic and institutional factors; moreover, it prejudices the issue since it again assumes, *a priori*, that more mankind necessarily produces more environmental degradation. Indeed, the same author explicitly states elsewhere that almost every region in nearly every country has excessive population growth (Holdren, 1992). In short, although considerable effort is made to account for social complexity, the profound and aprioristic conviction of the IPAT school that population size and growth are primarily responsible for environmental degradation nullifies such effort.

In sum, despite attempts at incorporating a more integrated view of the multiple determinants of environmental degradation, the IPAT formulation is inherently inadequate. Nevertheless, it continues to be frequently cited by policy-making institutions - particularly those in the population control or family planning field - as clear evidence of the need for widespread fertility control measures.

In this sense, it is interesting to observe that, although the use and interpretation of the IPAT formulation does not necessarily have to be neo-malthusian, its initial and lasting thrust has almost universally been interpreted as the very essence of controlism. Part of this is due to the incessant and well-publicized crusade of its principal authors in favor of population control. However, part is also due to the fact that these authors provide a much better characterization of population dynamics and of their alleged implications for policy formulation than of the other elements in the IPAT formula. Indeed, although the "Affluence" and "Technology" parts of the equation refer (albeit, vaguely) to the role of industrial civilization in environmental degradation, the explanation of these factors and of their policy derivatives pales by comparison to the vivid descriptions of population's roles and of the need for population control. This is why the vast majority of efforts aimed at limiting population growth for environmental reasons are legitimized with a referral to the standard IPAT contention.

## 2.2 The Revisionist Economists

During the past few decades, the most outspoken opposition to neo-Malthusianism, viewed as a generic approach, has come from the self-entitled "revisionists". This group is mostly composed of North American economist-demographers who make a distinctly "non-alarmist" assessment of the consequences of population size and growth. Most revisionists agree that the Third World would benefit from a slower rate of population growth but consider that its alleged role in resource depletion is exaggerated.

The evolving prominence of this school of thought would, in itself, constitute an interesting study. The works of Boserup (1981) and Simon (1981) have received the most attention in this context; their frontal disagreement with the population control thesis has generated considerable controversy in the mostly hostile milieu which prevails outside of American economics. However, a large number of other papers similarly argue the basic irrelevance of population factors to environmental degradation (Kelley, 1988, forthcoming; Srinivasan, 1988; Weir, 1988; Johnson, 1993).

The revisionist school currently considers the famous 1953 "D and C" publication by the Population Division of the United Nations as a seminal contribution to its position (UN, 1953). However, the most important documents produced by the revisionists were probably the 1971 and 1986 reports commissioned by the National Research Council of the National Academy of Sciences (NAS) of the United States. These studies constitute important landmarks in the debate. True, the 1971 report appears to be clearly alarmist, particularly in its more widely-disseminated executive summary. Nevertheless, this is because the summary basically contradicts the tenor of the major scholarly papers which underlie the report and which basically fail to find any significant association between population growth and economic development (Kelley and McGreevey, 1994). That is, the summary was apparently manipulated and did not reflect the position of the majority of the scholars involved in its preparation.

The subsequent 1986 report commissioned by the NAS unequivocally states a non-alarmist position. Nevertheless, it has, by comparison, been given much less play in population circles and in the mass media than the executive summary of its predecessor report. The 1986 study basically considers that concern with population growth as the cause of resource exhaustion, of savings and investment constraints and of shifts away from productive physical capital formation, is largely misplaced. The other side of this argument is, of course, that markets (also referred to as "Modern Economic Growth") will eventually solve everything, including rapid rates of population growth and environmental degradation.

Given the multifaceted political reinforcements which the market currently commands on the international scene, this view has gained considerable venue. In light of the current neo-liberal ethos of current economic growth strategies (i.e.— opening up of national and internal boundaries to the free flow of market forces), the importance of population growth logically has to be down played<sup>5</sup>. The school of thought which questions the validity of the predominant notion that higher rates of population growth have adverse effects upon economic well-being has thus been making increasing headway.

The perspective adopted in the present paper is that economic revisionism, like biological controlism, is conducive to oversimplified generalizations with respect to population's role in environmental degradation or well-being. Actually, if taken literally, its implications for environmental outcomes can be considered as potentially more dangerous than those of the population control school. Even if we concurred that all of humanity's current problems stem from market imperfections, the laissez-faire attitudes which it encourages are, to say the least, potentially risky. In other words, should market mechanisms take longer than expected to correct both population and environmental trajectories, the toll on humanity could be enormous. In the words of Herman Daly (1993:50) "...my major concern about my profession today is that our disciplinary preference for logically beautiful results over factually grounded policies has reached such fanatical proportions that we economists have become dangerous to the earth and to its inhabitants."

In short, the revisionist perspective does a good job of down-playing population growth's direct role in resource depletion or in constraining economic growth. Nevertheless, it cuts corners, overstates its case and oversimplifies the issue. One could also argue that it is misleading as to the historical role played by the State in economic growth, or that it exaggerates the practical possibilities of a free market without externalities or political constraints – but that would take us far afield. For present purposes, it can be criticized for assuming that disembodied market forces:

- a) are capable of generating acceptable growth and equity in all situations and contexts, or;
- b) that they are universally capable of overcoming the environmental constraints imposed by rapid population growth.

### 2.3 Alarmists and Revisionists: An Overview

From the foregoing, it can be argued that neither of the two dominant approaches to the understanding of P/E interactions provides a balanced outlook which is conducive to realistic solutions.

The population control solutions suggested by IPAT-type formulations appear to be more appealing and have probably had considerably more influence on public opinion and on policymaking at the world-wide level. Such approaches apparently constitute the "safe" outlook in the sense that, *ceteris paribus*, early reductions in population growth – while the dimensions of the population mass are still manageable – would appear to be a more prudent course than waiting for a possible world catastrophe. Yet, it also detracts attention from what this paper argues to be the key issue – namely the very nature of "development" in the future.

Meanwhile, the revisionist outlook is undoubtedly isomorphic with the current trend of development. It has had an important influence in downplaying the exaggerated emphasis placed on population's role in environmental degradation, and it has revalidated the very real importance of economic and technological factors in societal change. Nevertheless, its blind faith in market mechanisms and its understatement of probable future difficulties reads as a dangerous combination of natural law and fatalism.

### **3. Levels and Significance of P/E Interactions**

The main contention of this section is that in order to understand how, when, and in what ways population dynamics have an influence on environmental outcomes, it is necessary, first of all, to differentiate between types and levels of environmental problems. Second, it is necessary to link their evolution to ongoing economic growth efforts (Martine, 1993).

There are a great variety of environmental problems differentially affected by population growth, size and distribution. In turn, these constitute threats of widely-differentiated significance to the survival of humankind on planet earth. A basic weakness of the dominant P/E literature is its tendency to lump all environmental problems into the same undifferentiated category, without attempting to discriminate serious and generalized problems from minor and localized ones. Little effort has been made to rank the various manifestations of environmental problems and their sources. This failure makes it exceedingly difficult to gauge the significance of population's real contribution to environmental degradation.

The argument being made here is that the contribution of population factors to environmental problems has to be measured in terms of the latter's degree of intensity, gravity and reversibility. In order to illustrate the importance of such a distinction for the advancement of our knowledge of P/E relations, a simple and dichotomous separation can be made. On one side, a list of critical and global environmental problems will be drawn up; on the other, secondary and localized or temporary problems will be catalogued. Then, an attempt will be made to identify how, and to what extent, population factors affect each of these sets of problems.

For present purposes, critical/global environmental problems can be defined as those which adversely affect humankind's very ability to survive comfortably on planet earth and which can be expected to pervade, sooner or later, all (or the majority) of the planet's inhabited sub-regions. In addition, there is no known antidote or technology which can safely and economically counteract the effect of the problems described here as critical/global.

By contrast, secondary environmental problems are those which either do not endanger humankind's very survival or do so within a limited time or spatial framework. This category also includes problems which could threaten all or a majority of the world's population if left unchecked but for which technological solutions already exist or are in the offing.

There is evidently no generalized consensus as to the exact order or contents of environmental problems affecting humankind. Nevertheless, it can be suggested that the great majority of scientists would acknowledge that the more critical problems endangering humankind's survival on planet earth include, at least, the following: the depletion of the ozone layer, global climate changes, the accumulation of toxic chemical or radioactive wastes coupled with the exhaustion of unfilled sinks, the human over-appropriation of biomass, and the loss of biodiversity.

Secondary problems, by comparison, include a wide variety of environmental crises of variable gravity, durability, extension and reversibility. They are variously caused by the use of inappropriate technologies, maladministration of natural resources,

population growth, poverty or a combination of these factors. However, they are less acute and/or are restricted to a given part of the earth's surface. Moreover, they are subject to reversion, correction or prevention through development, political will, increased investment by the public or private sectors and/or foreseeable technological breakthroughs.

Under this category, varied forms of environmental degradation can be listed. These would include such problems as individual instances of nuclear accidents and other specific forms of radioactive contamination, acid rain, air and water pollution, desertification and other forms of land degradation, depletion of natural resources, and floods, *inter alia*. Each of these is undoubtedly serious in and of itself, while also contributing to the formation of global problems in the long run; however, their spatial or temporal restriction, as well as their susceptibility to control and reversion, place them in a less critical category.

What is the point of this (or another analogous) classification of critical versus secondary problems within the context of the P/E debate? Basically, such a taxonomy helps us to clarify the role and extent of population's influence on environmental problems. The following discussion attempts to illustrate this.

Most of the critical/global problems listed above presently derive not from population size or rate of growth but, rather, from the production and consumption patterns associated with industrialization; hence, they are largely attributable to development in high-income countries and, to a lesser but growing extent, to economic growth efforts of the less developed world.

In this connection, the following summary evidence reported by the UNFPA (1991:14) is worth repeating.

"With barely 25 per cent of the world's population, developed countries consume 75 per cent of all energy used, 79 per cent of all commercial fuels, 85 per cent of all wood products and 72 per cent of all steel production. In addition, developed countries generate nearly three quarters of all carbon dioxide emissions which account for half of the greenhouse gases in the atmosphere."

Given the dimensions of energy consumption and of non-renewable resources, of the emission of carbon dioxide, CFCs as well as other gases, and of the production of toxic wastes in developed countries, it is correct to assert that, at the present time, at least three of the five critical/global problems – depletion of the ozone layer, climate changes and the accumulation of non-disposable toxic wastes – stem directly from industrial civilization as experienced by the developed countries; only China, India and Brazil (the latter due only to deforestation, which is decreasing) need be mentioned in connection with ozone depletion and climate changes.

The over-appropriation of human biomass is probably divided fairly evenly between developed and developing areas. Hence, only the loss of biodiversity is clearly associated with poor countries having high population growth rates. Again, however, it is important to point out that this occurs because only the southern hemisphere has any biodiversity left to speak of. Even then, efforts at modern agricultural growth through the adoption of Green Revolution technology in various countries of the southern hemisphere are probably much more instrumental than population growth or poverty in total biodiversity loss.

By contrast, secondary/local/temporary problems are found, though in varying manners and proportions, in both developing and developed countries. Some of these (e.g. nuclear contamination and acid rain) are more characteristically found in developed regions, whereas deforestation, erosion and desertification are more common in poor countries. Still others, such as depletion of natural resources and floods, are found in both, although often linked to different causes.

A main point highlighted by this discussion is that population size and rate of growth *per se* cannot be blamed for the major environmental problems affecting humankind today. This is not to say that population is irrelevant. On the contrary, population factors are clearly associated with the aggravation of several forms of environmental problems classified here as secondary. Moreover, they unquestionably catalyze and contribute indirectly to the aggravation of critical global problems.

More importantly, however, the above discussion serves to point out that population dynamics fundamentally affect the dimension and gravity of environmental problems through efforts made by countries to achieve development. This occurs in two forms: 1) through population growth in the developed countries – where higher per capita consumption multiplies the impacts of each incremental person, and 2) through the increase in per capita consumption in developing countries, particularly in those having a large population and/or a high population growth rate.

The relevance of this point for the P/E issue is straightforward but, nevertheless, extremely important. Under present technological and environmental control levels, both population growth and economic growth in developed countries are environmentally dangerous. On the other hand, if the per capita consumption levels of the relatively small and slow-growing countries (under the same technological and environmental control conditions) were to be achieved by some of the large and/or rapidly-growing countries, the serious environmental problems of planet earth would inevitably multiply.

In both cases, then, population factors are unquestionably important. However, their contribution to the expansion of critical/global problems is conditioned by the shape and rate of development. In brief, population's contribution to global environmental problems will depend on:

- a) the rate and degree of incorporation, by poor countries, of the production and consumption patterns (i.e. economic growth) which currently prevail in industrialized countries;
- b) the size and rate of population growth in countries which manage to achieve or maintain high levels of economic growth;
- c) the rhythm of development and adoption of technologies which will permit more environmentally-friendly patterns of production and consumption, both in developed and developing countries – but particularly in large, populous ones.

The key issue, therefore, is that global environmental outcomes will depend fundamentally on the nature and on the success of development efforts undertaken by specific countries, particularly large and populous ones. There is undoubtedly a universal quest throughout the world for development. This is increasingly being defined, in practice, as economic growth; indeed, the quasi-philosophical discussions surrounding the nature of development have been largely silenced by the thrust of

efforts to achieve economic growth, which is seen to be, in practice, the source of other benefits.

The crucial issue in this context is thus: what are the prospects for economic growth in today's developing countries, particularly in large or fast-growing ones? Can these countries readily attain economic growth in the immediate or foreseeable future? With what consequences?

In turn, this brings up the question – what is the framework within which economic growth efforts are taking place now and in the foreseeable future? At the present time, there seems to be little doubt that the principal feature of the macro framework which will dominate the development scenario – and thus the nature and outcomes of P/E interactions – is the process of economic globalization. The next section discusses some of the ways in which globalization may affect this equation.

#### **4. P/E Interactions within the Context of Development: the Importance of Globalization**

A central contention of this paper is that in order to understand how P/E interfaces will affect humankind, it is necessary to situate them within the context of current development efforts. Evidently, relating P/E to development is, in itself, nothing new<sup>6</sup>. However, the interpretation of which aspects of development are critical differs here from the prevailing statement in the literature; more specifically, it is suggested here that P/E interactions must be situated concretely within the current scenario of economic globalization.

The point being made here is that P/E interactions must be analyzed, not merely in terms of their relationships with a specific sub-set of variables which are commonly taken as proxies or indicators of some aspect of development – such as affluence or technology – but rather within the more integrated and complex framework of development (i.e. economic growth) efforts such as they are construed today. In turn, this basically means inserting P/E relations within the evolving political and economic context of globalization. The next paragraphs discuss this phenomenon and some of its probable implications for P/E interactions.

The world is being progressively integrated and homogenized by communications, technology, financial flows, consumption patterns, cultural and behavioral patterns and even recreational habits. More recently, the disintegration of centrally-planned economies has added a catalytic factor to all previous forms of globalization – namely, the spreading ideology and practice of market economics. As a result of these recent transformations, the international division of labor is being altered and the flow of resources between countries and continents is being accelerated – with significant implications for the nature and gravity of global and local environmental problems.

Economic globalization has its roots in the structural crisis of the 1970s, caused jointly by the deterioration of the international monetary situation and the oil crises. The restructuring of capitalism in response to these predicaments generated three main types of world-wide consequences. First, capital/labor relations were modified to benefit a greater appropriation of surplus by capital through higher productivity, reduced wages and benefits, as well as decentralization of production. Second, the

role of the state was reduced in the internal sphere and yet modified to favor capital accumulation on an international plane. Third, economic processes were swiftly internationalized in order to increase profitability and expand markets (Castells, 1989).

The interaction of these three processes has greatly enhanced the legitimacy and feasibility of profit-seeking on a world-wide scale. Several historical occurrences converged in the 1980s to strengthen this trend. First, shifting political winds, resulted in the elections of Ronald Reagan and Margaret Thatcher, whose apparent successes in implementing neo-liberal policies in the USA and UK, respectively, provided considerable leverage to the ideological underpinnings of globalization.

Meanwhile, the gravity and duration of the world economic crisis in the 1980s forced most developing countries to redefine their economic policies. Widespread and intensive debt negotiations boosted the prominence of international financial institutions and gave their standard neo-liberal prescription for structural adjustment enormous political clout. The strength of the market ideology was further enhanced by the collapse of most centrally-planned economies. Similarly, the conspicuous economic success of a few Asian countries which had apparently adopted the tenets of neo-liberalism provided additional stimuli – despite the fact that more careful analysis shows the crucial role played by the State in the take-off of these countries.

Lacking any feasible alternative and driven by the exigencies of bilateral and multilateral international agencies, poor countries now have a single approach to development at their disposal, namely, the removal of all barriers to the free flow of capital and resources. The greater or lesser acceptance of this simple deregulation formula by a progressively increasing number of the world's countries has allowed capital to seek the most favorable conditions for investment and production anywhere in the world. The resulting free flow of resources for purposes of increasing profit and productivity is the essence of ongoing economic globalization.

As a result of this process, the rate at which capital circulates in its relentless 24-hour search for the most favorable conditions has speeded up enormously. In the interim, the financial and information industries have succeeded manufacturing as the key economic sectors at the world-wide level. At the same time, given the ease and rapidity of capital flows, investments, production and markets have become extremely volatile (Castells, 1989: chap. 1).

Of what importance is the process of globalization for the understanding of P/E relations? The basic issues at play here are twofold:

- a) will globalization of market forces, in fact, generate rapid economic growth – particularly in large, populous countries?
- b) will globalization contribute significantly to environmental degradation, particularly as concerns critical/global problems, or will it, on the contrary, help to alleviate such problems?

Without pretending to answer either of these complex and hotly-debated questions here, the following points can be made.

#### 4.1. The Prospects for Economic Growth

Traditional paradigms may be of relatively little use in predicting the outcomes of current economic growth efforts in the context of globalization. Standard market theory asserts that the removal of market imperfections on a world-wide basis will promote generalized economic growth. Indeed, deregulated international commerce, based on international specialization according to comparative advantages, constitutes the only available recipe for development today. Presumably, since the free flow of market forces heightens world-wide competition, each country or region will increasingly exploit its comparative or locational advantages to the extent possible in order to enhance its competitiveness.

Such advantages are not equally spread throughout the world. It can be postulated that the ability to generate or adopt new technologies determines the *primary* level of competitiveness on a world-wide scale. Yet, historically-accumulated advantages – in the area of financial or human resources, entrepreneurial savoir-faire, technology or natural resources – will not only continue to prevail, but will also tend to increase in the context of globalized competition.

The key issue for the present discussion is – what factors will increase competitiveness at the *secondary* tier of competition, (i.e. among those countries having little capacity to generate or adopt new technologies in the foreseeable future)? What are the comparative and locational advantages of less developed countries in a globalized world, given that they possess relatively little by way of capital, technological capacity or trained human resources?

Some of the comparative or locational advantages which different developing regions traditionally held may tend to lose their significance. For instance, the availability of a cheap and bountiful supply of manpower is an advantage which tends to become less important. On the one side, technological development greatly reduces the demand for many types of cheap and untrained labor. On the other, current global population increases of close to 100 million a year – most of which accrues to poor and highly-populated countries – greatly reduces the significance of large and untrained labor stocks.

Under these circumstances, the main question is: what instruments will developing countries use to compete in international markets? Development agencies exhort countries to increase competition and thereby reduce costs. But, as Daly (1993) points out, competition can reduce costs in two ways: by increasing efficiency, or by lowering standards in pollution control, worker wages, health care and so on.

Hence, environmental and social dumping are both realistic probabilities in the context of globalized competition. In other words, developing countries may be pushed to a competition based on spurious advantages by their lack of real comparative advantages. What will be the environmental outcomes of the strategies adopted by different countries to increase their participation in global economic activities? Will the willingness to part with natural resources, to ignore environmental outcomes of economic activity, or to serve as repositories for toxic wastes be a significant component of the secondary tier of competitiveness?

## 4.2. Economic Growth Efforts and the Environment

The quest for economic growth and development is practically universal in the end of century scenario. The approved path for economic growth suggests that poor countries should broadly emulate the production and consumption patterns of industrialized nations. Yet, this is a sobering prospect from an environmental standpoint. Indeed such production and consumption patterns are largely responsible for the critical and global forms of environmental destruction observed today. Technological improvements and changing consumption practices could greatly alleviate this situation in rich countries, even using only current knowledge. However, political will for such widespread change is still incomplete. This is basically because environmental preservation often clashes with short-term economic interests.

In some high-income countries, the value increasingly being placed on environmental quality and the related strengthening of environmentalist movements can conceivably lead to significant improvements in the relations between the economy and the environment in the foreseeable future. Improved technology, changing values and consumption habits can conceivably generate momentous changes in the near future.

However, to what extent can such advances be incorporated by developing countries? Their overwhelming priority is economic growth to create jobs, generate income and provide minimum sustenance and shelter. Their access to technology tends to be a generation late. Environmental preservation almost inherently involves investment and costs; hence it constitutes a luxury. Consequently, international differences in environmental standards are inevitable. Under such circumstances, is it realistic to expect that poor and middle-income countries will be willing to invest in environmental technology and protection during their take-off stages? Are there particular facets built into the free trade model which will necessarily benefit environmental causes?

There is still little consensus on this point. Economists and environmentalists are currently engaged in a heated debate concerning the probable implications of free trade. Some of the main arguments formulated at opposing extremes of the spectrum can be summarily sketched out<sup>7</sup>.

One side basically argues that the adverse effects of economic growth on environmental degradation can be greatly reduced. In this view, static assumptions about technology, waste and environmental investments are what underlie the pessimistic projections of growth impacts. The key is not to produce less but differently. Secular increases in the productivity of resource use will eventually produce absolute declines in resource throughput and pollution. Liberalized trade could actually speed up the diffusion of environmentally-preferred technologies and practices. By altering the structure of goods and services that are being produced, substituting away from resources that are becoming scarce and adopting clean technologies and management practices, economic growth is perfectly compatible with environmental conservation.

The alternate view holds that any prospect of economic growth is inherently threatening to source capacities and, more importantly, to environmental sink capacity. Trade and environment inevitably have different priorities. Economic growth in poor countries will only occur if there is even further growth by the rich, high-consumption societies, thereby increasing damage to global life support systems (as well as

sharpening existing inequalities). Markets feed on war, waste, planned obsolescence and the encouragement of superfluous consumption. Market mechanisms provide only limited and localized incentives to substitution of resources, technology and practices. Market incentives to migration of polluting industries and toxic wastes and market abhorrence of regulations can ultimately defeat conservation efforts made in higher-income countries.

Evidently, such perceptions are not easily reconcilable. The economists' view is optimistic with regard to the markets' capacity to generate technological solutions and promote their adoption. Environmentalists generally fail to see grounds for such optimism in either markets or human nature.

Without delving into this discussion at length here, the view taken in this paper is that, despite auspicious instances of technological breakthroughs, resource substitution and changes in consumption patterns, there is little cause for optimism. The inequalities of the globalized economy inherently favor the use of environmental and social non-regulation as leverage in international competition. Markets are ultimately governed by profit motives – which will generally react to environmental stimuli only when consumers and/or legislators oblige them. In many cases, this may be too late.

In short, the view of this paper is that the more probable scenario is one in which, left to their own devices, trade-offs between environmental and economic interests will often tend to be resolved in favor of the latter. The critical question in this connection – and one which again would take us far afield – is how social and environmental movements could alter the timing of environmentally favorable decisions. In order to have a meaningful impact, it is essential that, *inter alia*, such movements address critical issues. The next section deals with this question within a limited context – namely, the implications of globalization for the definition of research priorities.

## 5. The Locus of the Environmental Agenda

The 1980s marked a historic upsurge in environmental awareness all over the world. Throughout, most of the attention of environmentalists, policymakers, donors and researchers has been focused on rural-based ecosystems, tropical forests and the preservation of species – i.e. The Green Agenda. It will be argued here that greater emphasis needs to be placed on the interface between economic development efforts and global environmental problems, particularly within the context of densely populated urban areas, whose livelihood depends basically on secondary and tertiary sector activities – i.e. The Brown Agenda.

The two agendas are, in fact, inextricably linked. Preservation of biodiversity and of tropical ecosystems is indisputably critical to the survival of humankind on planet earth. Yet, such preservation will be extremely difficult to achieve if strategic and fragile land areas – such as tropical forests, wetlands and mangroves – are overrun due to the lack of viable economic alternatives. That is, the expansion of jobs in rural areas exerts direct pressure on natural resources.

Hence, without realistic development perspectives in other less fragile or less strategic areas, the long-range requisites of the Green Agenda seriously risk being overrun by near-sighted profit ventures or by the survival strategies of societies' poorer segments.

This happens, for instance, whenever large population contingents burn down the forests to engage in subsistence agriculture, or, whenever logging becomes a significant source of revenue in the context of a given nation's economy.

Hence, development issues are paramount for environmental conservation. This type of reflection sets the entire P/E agenda squarely within the framework of the current development scenario discussed above. The protection of biodiversity and of natural ecosystems is likely to depend on real development alternatives, primarily in non-primary sector activities and densely populated areas.

The urban context will thus be crucial in the evolution of future global environmental problems. On the one hand, cities will congregate an increasingly larger segment of the world's population and they will be more and more critical in future economic development efforts. On the other, environmental outcomes will be increasingly dependent on the trajectory of economic and demographic growth in the cities.

Traditionally, population concentrations have held the key to economic dynamism. Within the framework of globalized markets, the locus of economic growth will, in the majority of countries, be progressively more urban. The importance of the cities' comparative advantages tends to be greatly accrued in this scenario.

Thus, the World Bank estimates that between now and the year 2000, some 80 per cent of Third World GDP growth will originate in towns and cities; moreover, productivity will probably continue to be correlated with city size (UNDP/World Bank/ UNCHS, 1993). Consumption will also be increasingly concentrated in cities. In this light, it appears inevitable that the Brown Agenda will have to be given greater attention; the future of both preservation and global environmental changes are dependent on urban-based outcomes.

From a demographic standpoint, cities have long been growing at a much faster rate than rural areas. By the early 21st century, they will contain more than half of the world's population. Urban growth is particularly significant in poor and developing countries. By the year 2000, it is expected that there will be 21 cities of over 10 million inhabitants; some 17 of these will be in poor and developing countries (UN, 1991).

Several countries have an enormous potential for rapid urban growth. This is particularly true of large, populous countries such as China, India, Nigeria, Indonesia, Pakistan and Bangladesh which have, at this time, a predominantly rural base. One out of every four persons on earth now lives in a rural area of China or India. The case of China is particularly significant: one-seventh of the world's population lives in this country's rural areas, but the current economic revolution is breaking up traditional structures and transforming hundreds of millions of people into potential migrants. Efforts to understand and anticipate the probable environmental implications of such transformations are urgently needed.

In other regions, particularly Latin America, the rapid urban growth of the last few decades has already generated severe environmental problems which bear analysis and appropriate action. Rapid urbanization without economic development can produce enormous negative environmental impacts due to the lack of basic infrastructure, sanitation or health services. The homes of poor urban families constitute one of the most degraded and harmful environments to be found anywhere (e.g. Hardoy and Satterthwaite, 1989; ILO, 1992; Hogan, 1992).

Yet, the majority of people living in Third World cities are poor or living in miserable conditions. The rapid city growth of coming years will inevitably be associated with increasing numbers and proportions of such people. Moreover, environmental degradation during coming years will inevitably be hardest on the poor people in cities of Third World countries.

Nevertheless, it is fundamental to recognize that curbing urban growth is not the solution to either environmental or social problems. On the whole, past policies in the area of internal migrations and spatial redistribution have generally reflected an anti-urban bias. Concentration has commonly been viewed as undesirable. An implicit assumption underlying such policies seems to be that territorial equity, somehow helps to promote social equity (Martine, 1992).

As a result of this philosophy, deconcentration and interiorization through explicit policies has been systematically promoted in the development efforts of the last three decades. To this purpose, strategies such as growth poles, colonization of open spaces, regional development, industrial disincentives and the like have been common.

By contrast, implicit redistribution policies, whose impact is derived from the unintended consequences of productive investments, have generally favored concentration. That is, productive investments, even those made by the public sector, tend to be oriented by market mechanisms, and hence are channelled to those areas which hold comparative advantages. Given the fact that migration flows – and, therefore, the spatial distribution of societies – accompany the allocation of investments, economic activities and jobs over space, implicit policies have been more influential. That is, concentration has resulted, in large part, from the free flow of market forces – despite the systematic efforts of governments to the contrary.

Since, on a world-wide scale, the current politico-ideological scenario and, thus, the foreseeable future, favors market mechanisms even more, it can be expected that the propensity to concentrate investments and activities in urban areas will be accentuated. Hence, migration flows to the cities will continue.

This should not be discouraged outright since – contrary to the conviction which has prevailed for many years – the concrete possibilities for economic growth, and thus for the resolution of economic and social problems of the poor, inevitably lie in the outcomes of development efforts in urban areas. By the same token, even environmental outcomes are directly dependent on the ability of urban areas to absorb population productively and thereby to generate the necessary resources, technology and political will for environmental improvement. Consequently, concentration is both inevitable and desirable; nevertheless, much greater explicit effort will have to be directed to the cities before they can achieve their potential in terms of resolving social, economic and environmental problems.

Social and environmental problems are closely linked. Poor people in urban areas face critical survival problems associated with the lack of safe water, sanitation and drainage. Moreover, the problems generated by inadequate waste management, uncontrolled emissions and environmental accidents directly affect the living conditions and the health of the poor.

Cities are also major centers of pollution and resource degradation. Urban warming is itself a major source of concern. Urban emissions not only contaminate the air

consumed by the urban population but, they also represent an increasingly significant share of the gases responsible for global climactic changes and the depletion of the ozone layer.

As major centers of production and consumption, cities also rely on a very high input of resources such as fossil fuels and water. Unless important precautionary and corrective investments are made, the water that cities use in industrial activity is returned to rivers and lakes at lower quality. Urban sprawl uses up valuable agricultural land and creates the need for energy-intensive transportation systems.

In short, there are several powerful reasons why P/E interactions should begin to be addressed preferentially within the framework of urban settings. This is of considerable significance for the agenda of P/E studies. It also should help redirect the thrust of environmental movements and their supporters.

## **6. Conclusion**

The current debate on population and environment is largely at a standstill. Not only are many of the participants deaf to each other's arguments but the main thrust of the controversy fails to take account of how P/E relations will be affected by the principal phenomenon in the current end-of-century scenario – namely, economic globalization.

This paper has argued that deregulation and increasingly internationalized competition are exceedingly important for global environmental outcomes. To understand the role played by population dynamics within that context, it is helpful to distinguish between critical/global versus secondary/localized/reversible environmental problems and to identify the contribution of population dynamics to both of these within the context of ongoing development efforts. This exercise highlights the fact that population's central contribution to environmental degradation is basically channelled through economic growth.

Hence, the nature, form and timing of the impact which population dynamics have on critical environmental problems are dependent, to a large extent, on P/E interfaces in industrialized countries, and on whether poorer countries will achieve a similar economic growth. In turn, the trajectory of economic growth will be determined by the evolution of ongoing globalization.

Such reflections argue for the need to review the terms of the population/environment debate. They also counsel a shift in the terms of the environmental agenda, away from what can sometimes be perceived as a quasi-exclusive concern with rural-based ecosystems, to a greater emphasis on social and environmental outcomes in densely populated urban areas. Cities will not only hold a majority of the world's population in the 21st century but they will also harbor most of its economic activity. Hence, the trajectory of economic growth, the resolution of social problems, the definition of environmental issues – in sum, the kind of world we are to live in – will be defined in the cities.

Neither blind faith in the power of markets nor in population control are conducive to generating the kinds of technical information, nor the magnitude of social, political and environmental awareness which are necessary to begin dealing with the awesome dimensions of this challenge.

**Note:** An earlier version of parts of this paper was presented at the Third Conference on Environmental Security, Tufts University, 31 May – 4 June, 1994, under the title of "Population/environment relations and international security: the impacts of globalization."

## Footnotes

<sup>1</sup>"The total negative impact of an [agricultural or technological] society on the environment can be expressed, in the simplest terms, by the relation  $I = P \times F$ , where  $P$  is the population, and  $F$  is a function which measures the per capita impact" (Ehrlich and Holdren, 1971). The actual IPAT equation was first used in late 1971 and published by Ehrlich and Holdren in *Environment*, April 1972.

<sup>2</sup>"In fixing the blame for environmental deterioration on faulty technology alone, Commoner's position is uncomplicated, socially comfortable and, hence, seductive. But there is little point in deluding the public on these matters; the truth is that we must grapple SIMULTANEOUSLY with overpopulation, excessive affluence, and faulty technology" (Ehrlich and Holdren, 1972), (emphasis in original).

<sup>3</sup>Actually, Commoner's formulas appear to be even more simplistic. His most recent attempt at redefining his [Pollution = Population x Good/Population x Pollution/Good] is singularly unconvincing (Cf. Commoner, 1992).

<sup>4</sup>A recent formulation along the lines of the basic IPAT argument illustrates the nature of the problem. This states that: "A single measure – population times per capita resource consumption – encapsulates what is needed to achieve sustainability" (Goodland, Daly and El Serafy, 1992.). Although the author of this phrase is perfectly aware of differential consumption patterns – and castigates the rich for their destructive rates of consumption in other parts of his text – population control ends up being the only cogent proposal to the solution to environmental problems. Other (and more directly important) aspects of the problem are inadequately discussed.

<sup>5</sup>There are, of course, ambiguities amongst the defenders of this school of thought. For instance, the World Bank – along with most multilateral development agencies – has long been a defender of the need for population control. At the same time, it is one of the strategic champions of the advantages of market economics. The Bank's 1992 World Development Report, for instance, makes an explicit defense of both outlooks.

<sup>6</sup>The United Nations Expert Group on Population and Environment, for instance, explicitly introduced the term "development" in the title of its meeting. Nevertheless, as Commoner (1994:64) points out – "It is now widely appreciated that there are important relations linking population, economic development and the environment. There is, however, little agreement about the nature of those links, and what guidance they can provide about the relevant policy options.

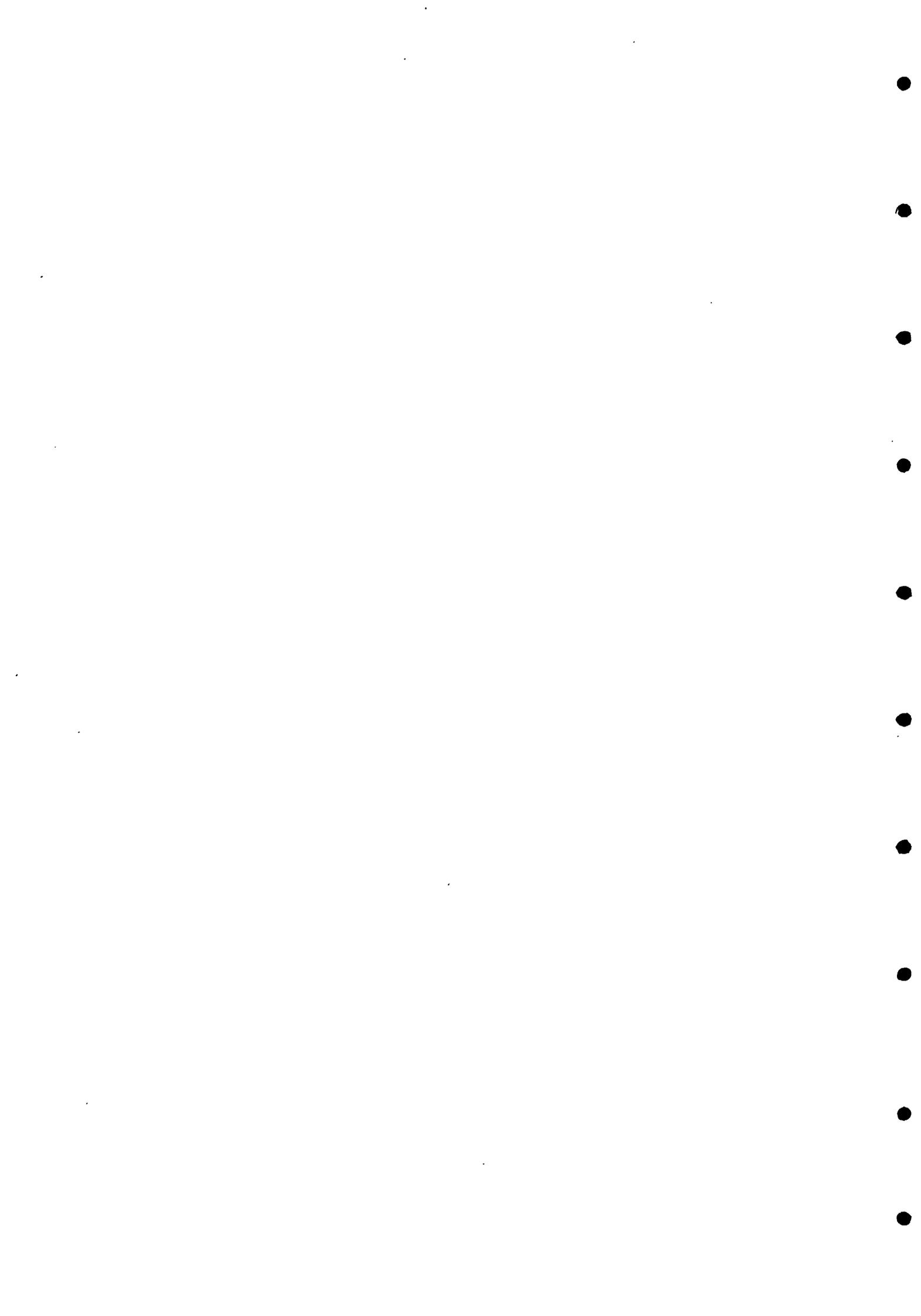
<sup>7</sup>The rather oversimplified and somewhat caricatural sketch presented in the next two paragraphs are composites based on arguments from many readily-available sources.

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## CHAPTER 6

# POPULATION AND ENVIRONMENT IN THE 1990s: THE NEED FOR A SUBSTANTIVE DEVELOPMENT LINK

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### 1. Introduction

Population and environment studies have known an impressive rhythm of expansion in recent years, and valuable efforts have been made in the quantitative assessment of relevant aggregates.

Many participants in these debates do however recognize the need for new break through in the conceptual approach. In this respect, one has indeed to recognize that most of the topics and concepts have been already explored or encompassed in the fields of population and development and of development and environment studies. One has even the impression that in many cases the conceptual framework draws heavily upon even older references, which have influenced the study of population and development. It seems that there is a certain continuity between the mainstream population-development doctrines of the 1960s and the mainstream vision of the relation between population and environment in the 1980s.

If many international organizations do agree upon the necessity to integrate population and environmental aspects (UNEP, World Bank, UNFPA), the proposed type of integration is often rooted upon rather simplistic assumptions. Most of the international organizations share the view that population growth does play a crucial role not only in the reduction of resources availability for development, but also in the destruction of the environment.

Such a conviction provides a new basis to justify the need for very active policies in the field of fertility control. One can therefore have the impression that for many in the 1980s "environment" has simply replaced "economic growth" as a new justification for population control. The latest is looked as ever as a simple and easy tool (for instance through a sharp rise in budgets devoted to family planning) to reach some quick results, and even when some recognize that a slower population growth will not solve all the economic and environmental problems they give a high value to its contribution to face "the urgency" (World Bank, 1991).

Many scientific contributions in the field of population and environment follow the same path of reasoning. One well known example is the sequence of versions of the Ehrlich and Holdren equations:  $I = P A T$ , where  $I$  is a negative impact on the environment,  $P$  the population size,  $A$  affluence or the per capita consumption, and  $T$  is "an index of the environmental disruptiveness of the technologies that provide the goods consumed". (Ehrlich & Ehrlich, 1990). One can remember that according to the

Ehrlich's, the I = P A T equation is a key to understanding the role of population growth in the environmental crisis, and there is no practical way to achieve the necessary reduction in greenhouse emissions without population control. Without elaborating much more, it is obvious that the "link" between population and environment in this case is a very rough vision of "development" rooted upon hugely aggregated patterns of energy consumption at the world level.

The above mentioned positions illustrate the fact that in reality, a certain development vision is always present in the studies relating population and environment. Most of the time, it is implicit, which renders any assessment very complicated. Even when a reference is made explicitly to development, it is often in relation with one or other mainstream definition of development. Then, willingly or unwillingly, the population and environment topic is drawn in the framework of mainstream development theories, as if they were a sort of natural or "common sense" evidence. This in fact may contribute to a certain poverty of the conceptual framework, and to an insufficient exploitation of interesting insights concerning the linkages between population and environment.

The central idea of the present contribution is that the conceptual framework of population-environment studies could be enriched considerably, if not uniquely, through the multiplication of linkages between the three fields of population, environment and development. An effort has to be made however to overcome the bottlenecks associated with the fact that binary approaches of the three fields have prevailed until very recently. Most of the literature has been centred around population and development, development and environment, and then population and environment. This has been made more or less in a succession of stages, with many shadowy areas left between the three fields and with a growing confusion.

In order to escape that confusion and before exploring more explicit linkages between the three fields, an effort has to be made towards clarification. This is required because despite the past preference for binary approaches, the three fields have been intertwined through the pervasive influence of paradigms. These have shaped the three fields in different ways of thinking along common visions or prejudices, which divide them according to differences in global perception, rather than along disciplinary frontiers.

Finally the three fields can be regrouped along competing paradigms. A very simple way of approaching these categories could be to classify them in mainstream and counterpoint ones. This contribution will try to show that behind the sequences of formal binary approaches, the three fields can be regrouped in these sorts of intellectual frameworks, corresponding in some cases to elaborated schools of thinking. The prevalence or obsolescence of the different frameworks and paradigms can be associated with different historical contexts. One has indeed to insist upon the independency which links the theoretical aspects with the political dimensions. The problem is not simply to find the "good methodological path toward interdisciplinarity".

"Real world" constraints have linked the search for interdisciplinarity and the need for action. The dominant binary approach of the past has been heavily influenced by the geo-political international context and by political controversies which have raged about North-South relationships.

These points can be illustrated by a brief survey of "mainstream" and "counterpoint" approaches in the three fields. Such a survey could help to much needed clarification

in the present controversies. It could perhaps contribute to highlight the role of some new pragmatic tendencies in the three fields. That pragmatic evolution could in the future promote better linkages or even integration between the fields, through a more substantive definition of the development framework.

## **2. Population, Development and Environment in the Framework of "Dogmatic Modernization" before 1980**

In the last fifty years, which have seen the rise and blossoming of contemporary development thinking, "mainstream" development studies have been heavily influenced by the "modernization school" paradigm. For that mainstream tendency, development was a sort of universal process, with different stages through which all countries and societies were supposed to reach a final stage of prosperity so well popularized by the Rostovian view (Berthoud, 1990).

According to that conception, development is symmetrical to the rise and consolidation of a modern sector which has to absorb progressively the traditional sector through a process of social and institutional differentiation, cultural secularization, and an increasing division of labour supported by the increase of the investment rate (Rist, 1990).

In the field of population, mainstream theories were always very close to the vision of the modernization school. The demographic transition theory has been a part of it and has contributed to provide a vision of the "backwardness" of traditional societies which have to catch up with the "modern" pattern of demographic behaviour already reached by industrial societies (Higgins, 1968). Demographers try to grasp the universal patterns of change toward progress, and to provide a formal structure of transition analysis. Like development economists they have had a paramount influence in the modernization school, because they were keen to provide a quantitative assessment of their theoretical propositions (anteriority of mortality fall; a two phased model of reproductive transition with marriage limitations predating birth limitations).

Demographers and development economists of the modernization school shared common beliefs about the interdependency between the demographic and economic aspects of transition. For demographers sustained economic growth is seen as a key factor to foster the decline in population growth (Notestein, 1953). Traditional behaviours were held responsible for the delays in the "normal" pattern of transition. Development economists gave a key role to the demographic variable. For the "pessimists" population growth was a major obstacle to the so-called "take-off" in the field of economic growth, because population increases divert the gains in incomes from saving and investment to consumption (Meier & Baldwin, 1957). There were many variants of the same perspective, from the "low level equilibrium trap theory" to the "stationary state" theory (Nelson, 1956). For the "optimists", in "dualistic societies" threatened by the "Malthusian trap", sound policies could mobilize the "labour surplus" from the traditional sector to foster economic growth in the modern one.

One has also to underline here that in the modernization view, there was a strong implicit link between development and environment, as nature was seen simply as a sort of unlimited stock of material resources, which had to be taken away from an

inefficient traditional society (the "tragedy of the commons" story being one of the many versions of that approach) and be mobilized for a greater productivity with the rise of a modern industrial sector.

Modernization was really an interdisciplinary paradigm, with a pervasive and long lasting influence upon all the disciplines having contributed to population and development thinking. Development being defined mainly as structural changes functional with rapid economic growth, all other dimensions of society and nature were looked at from an instrumental perspective. This was especially conspicuous in the field of population studies, people being looked upon as variables in models of behaviours defined exogenously from the living contexts. Societal structures were analysed mainly through some privileged aggregates of macroeconomic and demographic variables.

All disciplines were obsessed with a conceptualization of the development process in terms of a rapid and even violent breakdown with the past, be it a "take-off", a "big push" or a "big spurt". They were also very eager to propose some universal patterns of modernization rooted upon some sort of teleological vision of history.

Due to the mounting contradictions between its predictions and the "reality of the world", "dogmatic modernization" entered a period of crisis in the second half of the 1960s. That crisis has entailed the rise of "counterpoint" tendencies, the two most conspicuous being the "dependency school" and the "ecological" or "ecodevelopment" tendency.

For the dependency school the roots of underdevelopment had to be sought in the historical process of capital accumulation at the world level, leading to growing inequalities between social classes and especially between "center and periphery" countries (Palma, 1978). Active policies against underdevelopment required strong institutional reforms inside nation-states, and among states (through an increasing role of UN institutions like UNCTAD) to redress the growing imbalance between North and South. The radical version of the dependency school, close to the Chinese revolutionary vision of that time, was strongly opposed to any proposed negative link between population growth and development (Finkle & Crane, 1985).

The ecological counterpoint tendency has begun, at the same time, to question the close association made between economic growth and development, with a special emphasis about the negative impact of accelerated growth upon natural resources. It was clearly asserted, in opposition to the modernization school view, that the exhaustion of natural resources could result from wasteful types of economic growth as well as from uncontrolled population growth (Sachs, 1993).

The crisis of the dogmatic modernization tendency has however stimulated reactions inside the modernization school itself. An even more aggressive version of modernization was elaborated. It proposed to foster economic growth by a clear cut reorientation from inward-looking industrialization strategies to more outward oriented activities, with less subsidies given to industry in order to give priority to the modernization of agriculture (Green Revolution policies). At the same time this new orientation gave an even greater priority to birth control policies, giving much publicity to very gloomy perspectives upon population growth running ahead of food output growth.

That vision was not independent from geopolitical contingencies, as clearly expressed by Benedick, a former coordinator for Population Affairs at the State Department in Washington:

"United States government preoccupation with population problems is based upon a keen interest for economic development and political stability at the world level. Disequilibrium and changes entailed by an unprecedented rate of population growth do contribute to an increasing risk of political instability, social unrest, extremism, mass migrations and international conflicts concerning scarce resources of the earth" (Benedick, 1984).

The "ping-pong" diplomacy initiated at the beginning of the 1970 by the United States and China has had an impact upon these controversies and upon the fate of population and development linkages. Finally, in the wake of the 1974 Bucharest Conference, some sort of compromise was made between the anti-Malthusian and the neo-Malthusian tendencies. It was accepted, at least in principle, by both sides, that the best link between population and development was the acceleration of economic growth, especially in poor countries. Growth had to be coupled with specific redistribution policies, in order to alleviate poverty, recognized as the main cause of population growth. In this context, the priority being given again to economic growth, conventional modernization ideas have reasserted their dominance in the 1970s, with a spectacular reversal in that direction by China itself.

Population and development strategies superseded in the short term the environment topic, even if government paid lip services to it, by adhering to the conclusions of the 1972 Stockholm Conference. In these conditions, counterpoint preoccupations developed mainly in the field of environment, with a multi-faceted search for an "other development".

During the 1970s, counterpoint thinking sharply criticized the modernizing vision of nature as an unlimited stock of resources which could simply be mobilized for growth. This led to a revision of the modernization assertions about the inability of "traditional societies" to manage their environment. This was supported by efforts to understand the specific features of non-western socio-economic systems which enabled them to reproduce themselves in the long run. They were attempts to show how their "substantive" rationality was geared to the construction of complex institutional systems to ensure the management of both nature and society. That led to the search for more endogenous forms of development, respectful of the cultural identity of populations having a specific cultural heritage (Verhelst, 1987).

For counterpoint theorists in the 1970s, the opposition between tradition and modernity was a artificial one, which lacks historical and anthropological evidence. There is no evidence that tradition is responsible for hampering modernization, but on the contrary many facts point towards the negative consequences of modernization upon viable social structures and environment (Diakite, 1985). Such an evolution in counterpoint thinking had a far reaching, even if inconspicuous, impact upon the concept of the relation between population and development.

Many studies insisted upon the negative externalities, associated with rapid modernization policies, and their destabilizing effects upon local populations. Macro-level strategies of industrialization as well as micro-level agricultural projects could destroy the life environment of numerous populations, rendering them more fragile and

prone to impoverishment, migration, and disease (Lipton, 1989). Population in this respect is no more only a "variable to control" (like in the modernization view), or the "popular masses to mobilize" (like in the more radical versions of the dependency school), but is looked upon as "people", whose needs and demands for better life do matter.

Even if counterpoint tendencies of the 1970s had no great weight in the "real-politik" decision making process, one has to recognize their contribution to a more open and richer definition of development, with new insights about its potential relation with population and environment.

### **3. Development, Environment, Population and the Rise of the "Neo-Modernization" Paradigm since 1980**

The basic principles of the modernization theory have exerted a strong influence in the 1980s, even it is in a different context and with a different overtone. The global vision inspiring adjustment or "adjustment with growth policies" so influentially proposed by the powerful Bretton Woods institutions is rooted in the same basic principles of the modernization school.

There is a universalist vision and search for a global order. But now that vision is more constraining than in the past: one has simply to adjust to it. At the same time, the weight of the economic dimension is heavier than in the past. Then economic modernization was a component, among others, of the nation-building process; now it is an hegemonic principle of organization, which does impose its norms to all the other components of the social and political system.

One can say that one has evolved from the "national modernization dogmatism to the transnational neo-modernization dogmatism" (Peemans, 1992a). In the latter, the international does command the national, the enterprise norms command the state, the private sector imposes its priorities upon the public sector, and modern sector economic growth is seen as the result of an efficient adaptation to the constraints of the international economy.

In the population and development field, the 1980s have seen some contradictory evolutions inside the mainstream framework. On one side, one has seen the rise of a powerful neo-conservative tendency, initially in anglo-saxon countries, which played an ever greater role in the definition of what development ought to be. Its ideological stand was forceful, with an exacerbated anti-state bias, excessive state intervention being presented as the main factor for the poor performances of most developing countries. State intervention has to be reduced in economic activities as in social ones, with appropriate cuts in anti-poverty programmes and even family planning programmes. Starting with the prejudice that poverty as well as unchecked family size are the results of irresponsible individual behaviours, that ideological tendency does assert that extended anti-poverty programmes can only stimulate the poor to have more children. Moreover, it opposes birth control programmes, because it would enlarge the scope of state intervention and extend its power over individual lives (Simon, 1981). For that line of thought, these arguments seem to be even more

powerful than the traditional fears about unchecked population growth in the Third World.

On the other side, the neo-liberal tendency shared the anti-state bias with the neo-conservatives along with a strong sympathy for a deregulated and globalized free market economy under the aegis of transnational corporations. However, this line of thought has continued to give support to population policies, because high population growth rates are seen as obstacles to adjustment efforts. Therefore, they have a common attitude with the main multilateral institutions, which favour the allocation of a more important part of severely adjusted state budgets to birth reduction programmes (World Bank, 1987).

In this respect, one can conclude, that for the mainstream approach in the 1980s, the relations between population and development are still very close to the ideas prevailing thirty years ago. In the framework of "dogmatic global neo-modernization" population is a tool, a variable or an obstacle for adjustment and globalizing growth policies, whereas for "dogmatic national modernization", it played the same role, but inside the frontiers of the nation-state.

The population-development nexus has contributed in the 1980s to reinsert a greater part for environment thinking in the mainstream approach. This is linked with the increased importance given by influential environmentalists, especially in the USA, to population growth as a cause of the environment destruction (Brown, 1991).

Due to the interest of many neo-conservative circles for the conservationist approach to environment problems, the way neo-Malthusian environmentalists focused upon the population-environment link has helped to bridge the gap between mainstream tendencies. The insistence with which the irresponsibility of Third World countries was underlined in the destruction of environment helped also to attract sympathy from the neo-conservatives. The ranks of the mainstream tendencies were therefore enlarged, encompassing now some new environmentalist recruits.

In this context it is obvious that mainstream environment views are close to the neo-modernization approach in the field of development. For the most open and long-term minded neo-liberals, environment is a part of sound growth policies, which require a rational management of exhaustible natural, energy and biological resources. Environment is encompassed in a naturalistic and holistic approach. The main topics are therefore climatic changes, protection of the atmosphere (including the ozone layer), deforestation and desertification, the management of wastes, and the protection of the oceans and of biodiversity (UNCED, 1991). A sustainable growth requires also a rational management of its impact upon the great natural and climatic equilibria (Barbier, 1989). According to that view, growth and environment can adjust to each other in the long run, through a continuous flow of new "clean" technologies (Pezzey, 1989). As that approach shares the prejudices of the neo-Malthusian current, economic growth is seen as a condition for environment protection in the long run because of its supposed positive consequences upon the reduction of population growth and mass poverty in developing countries.

Environment can become itself a component of world growth in the long run, by opening new opportunities for huge investment in pollution cleaning equipment and industries. Moreover, according to certain representatives of that mainstream tendency a rational and balanced approach of the relations between growth and environment at

the world level would encourage the transfer of polluting industries toward countries with lower wages and human costs, where there is a "deficit of pollution in terms of economic efficiency". A transfer of polluting industries from the North to the East or the South, where, with the ongoing equipment, pollution is higher for less economic efficiency, would contribute to the reduction of global pollution at the world level (Summers, 1992).

It seems therefore obvious that, for mainstream tendencies in the three fields "sustainable development" is only another word for "sustained growth". Population and environment are absorbed as subsidiaries of sustained growth. Conventional growth strategies are promoted as the sole engine of poverty alleviation and therefore of demographic problems. At the same time, "clean" growth strategies will ensure their long-run sustainability.

Mainstream tendencies in the three fields have kept the same dogmatic approach which was proposed more than forty years ago by modernization theorists. They are even still more normative and single minded, with a will to reorganize societies around the world, according to the principles of the neo-modernization paradigm. That sort of conceptual bottleneck of mainstream tendencies has worried an increasing number of independent observers, and entailed the search for new ways of sustainable development.

#### **4. The Search for a Sustainable Development Approach in the 1980s, and its Influence upon Population and Environment Studies**

If at the beginning of the 1980s, the discourse on adjustment has monopolized the reading of development problems, it has become obvious for many observers, at the end of the same period, that adjustment policies cannot cope with the new pattern of the accelerated and deregulated globalization of the world economy, nor with its huge destabilizing effects upon existing social and political structures (Bergeron, 1992).

Facing the pervasive dogmatism of mainstream tendencies, one has therefore seen a growing dissatisfaction and an increasing scepticism about the relations they establish between the three fields. This has entailed a new counterpoint approach which has raised many questions that have influenced the way of thinking of many other theorists. It has tried to escape the pitfalls where the dogmatic approaches have led through oversimplistic attempts to establish direct and global links between population growth, economic backwardness and/or environmental degradation.

One of the most useful contributions of the counterpoint thinking has been to show that single-minded definitions of development in terms of economic growth and performance according to international standards, are unable to encompass the contradictory impact of internationalization upon the complex web of social life, a reality which matters in terms of development. The new realities of the globalized economy can not be reduced naïvely to increased performances in terms of profit-making activities. They are also enmeshed with growing tendencies toward social polarization and fragmentation (Mingione, 1991), with new forms of urban and agrarian crisis (Bernstein, 1990), with unpredicted types of social anomy and lack of identity

(Mazlich, 1991), of social violence and conflicts (Bula, 1990), which cannot anymore be explained by the resistance of traditional structures.

New counterpoint tendencies are also pointing to the devastating consequences of globalized growth upon environment at the world level, but with an especially negative impact upon developing countries (Smith, 1990). According to that view the unconstrained logic of accumulation is per se a wasteful process of resources and space consumption. The new and harsher features of competition between performing growth poles at the world level entail an accelerated destruction of environment, in industry as in agriculture (Redclift, 1987).

Negative social and environmental externalities are growing at a faster rate with the accelerated internationalization of the economy (Lele, 1991). This can be attributed partly to an increasing tendency toward deregulation, many states trying to enhance their attractiveness to foreign capital through the softening of the national regulatory framework, and with no powerful enough compensating regulatory structures at the supranational level (Daly, 1990). According to that line of thought, they are new perverse linkages between environmental and social costs, as the new features of globalized growth are entailing new forms of mass exclusion and marginalization. In many cases, that new type of "global poverty", endogenous to "global growth", leads necessarily to some savage survival practices of local populations, with very negative consequences upon the local environment.

For counterpoint observers, the neo-Malthusian direct relation between population and environment has no explanatory power in face of these realities. On the one hand, that direct relation is rooted upon a vision of mass poverty as a residual of the "traditional society" which has to be met by accelerated growth policies. It can therefore not tackle the contradictory aspects of "globalized growth". On the other hand, its catastrophic predictions rely upon macro projections of incomes and pollution associated with that globalized growth, and with demographic macro-projections about "tradition and poverty ridden populations". As these "traditional populations" have still to "catch up" with the "global modern", the conclusion is then obvious: the threatening environmental plight could be alleviated only by a greater effort toward population control.

For some authors, that neo-Malthusian view is misleading because it makes evaluations of population, environment and development macro tendencies at a grossly inappropriate level of aggregation. That aggregation problem, has been addressed recently by different studies. For instance, splitting the world population into four groups, each having supposedly homogenous demographic patterns and CO<sub>2</sub> emissions, it has been demonstrated that the extension of the UN medium variant population projection results in only a 20 per cent increase of total carbon emissions over the next 60 years assuming constant per capita emissions (Lutz, 1992). This is much less than the 86 per cent increase that results from treating the whole world as one homogenous region.

In the same vein, attempts have been made to quantify the role of population growth in past CO<sub>2</sub> emissions by presenting the results of a set of scenarios that show how important the world CO<sub>2</sub> emissions from fossil fuel and cement would have been had the population and/or the CO<sub>2</sub> per capita followed different paths of evolution during the period 1950-1990. The scenario results tend to show that, for industrial CO<sub>2</sub> emissions between 1950 and 1990, past population increases in developing countries have

contributed much less to the CO<sub>2</sub> increases than either increases in consumption or population growth in MDCs. They also remind that past and present emissions per capita in developed countries are not extendible to the rest of the world, even if populations had been blocked at the 1950 level, since they dramatically increase already excessive emissions. The scenarios with the lowest total emissions imply the extension of LDC consumption patterns to MDCs as well, with or without population control, illustrating in a striking manner the very small CO<sub>2</sub> emissions per capita associated with the way of life of LDC inhabitants (Bartiaux & van Ypersele, 1993).

These exercises about numbers illustrate in a striking manner the concept of "differentiated responsibilities" introduced in the 1992 Rio Convention. Firstly, since the fraction of the world population which grows at the fastest rate is also the one with the lowest per capita emissions, using average population growth rate and average per capita emissions will overestimate world emissions. To assess the relation between population and development, one has to include specific features of production and consumption patterns associated with huge differences in income levels between different types of populations at the world level. Secondly, since changes in consumption patterns are affected by a weaker structural inertia than population, it may be argued that it would be more rapidly effective to put the emphasis on changing the energy and resource consumption patterns especially in rich countries. Such reduction can be necessary to allow a sustainable development while waiting for the outcome of the reduction of population growth.

At that global level, historical evidence does show that a small minority of the world population located in the northern hemisphere does bear a huge responsibility for current problems of pollution, resource depletion, and negative effects of a production pattern heavily and long dependent upon a disproportionate share of world fossil energy consumption (Commoner, 1991).

There is a growing recognition that to be serious about "sustainable development" one has to address the very nature of development processes. "Hard growth" production and consumption patterns are inextricably intertwined with a huge destructive impact upon the environment. This is especially the case in the North where voracious consumption patterns are associated with massive overcrowding and congestion of urban spaces, destruction of rural landscapes and degradation of the historical heritage (Gallopín *et al.*, 1989).

In recent years, counterpoint tendencies seem to have certainly enlarged their influence upon the normative search for sustainability. They have contributed to underline that the definition of sustainability criteria requires a sort of holistic perspective, which could be an alternative to the very normative approach of mainstream thinking.

That search for an alternative normativity points to the question of assessing different global scenarios of development styles. It leads also to the necessity of finding new ways of linking the relations between population and environment to the relations between population and development, and even to the question of the nature of the development process itself.

## **5. The Contribution of Pragmatic Approaches to the Search for Integration Between Population, Environment and Development, with Special Reference to the African Context**

There is thus no firm ground to establish at the theoretical level a direct relationship between population growth and environment degradation, and one has to avoid extrapolation from a strictly mechanical and numerical approach of demographic problems at a global level. There is no methodological reason to propose a direct link between population and environment and to isolate them from the global setting of social, economic, institutional and political aspects with which they are interplaying. By widening the range of mechanisms which can affect the process of environmental degradation or destruction, one can also enlarge the scope for policy and increase the number of tools for intervention (Thiltges & Tabutin, 1992). On the contrary, an obvious consequence of a narrow minded approach is that in countries where there is some lack of conviction or even reluctance about the current policies proposed by international organizations in the field of population, one is devoid of instruments to tackle the need for improvement in the relations between population and environment.

This is particularly true in the case of many African countries which until the beginning of the 1980s were ready to implement some sorts of "basic need" policies, with a positive impact upon population as well as environment problems (child and mother care policies with a positive impact upon child mortality rate, or water quality policies with a positive impact on both health and environmental aspects). These were in fact indirect sectoral policies which could be substitutes for direct population and even environmental policies with a positive impact in both fields. But during the eighties, due to the constraints of adjustment policies and the reduction of state ability to finance such projects, this sectoral approach has been greatly weakened and one is left with a vacuum in the field of appropriate population policies.

The same is true in the field of environment. Few African governments have taken global measures to protect and improve the quality of environment. Some of them have made real and interesting efforts in that direction. This is the case of some interstate organizations, like CILSS (Comité permanent inter-Etats du Lutte contre la secheresse du Sahel), which have undertaken important sectoral programmes with a practical positive impact upon environmental problems (land and water conservation and anti-desert programmes and integrated resources management programmes linked with rural and agricultural development projects). The global results of these actions are however limited for a number of interacting factors. The international economic context has not been favourable: to say the least, the decline of primary product export prices, the persistent high interest rates and the reduction of aid financial flows have constrained heavily the intervention potential of nation-states.

At the same time, many capital intensive agricultural development projects undertaken in previous decades have, during the 1980s, definitely shown their negative impact on population and environment problems. In West Africa for instance, some ambitious programmes devoted to the settlement of new lands (North-East Benoue and Volta Valleys projects) to solve overpopulation problems in some areas, have been unable at the same time to control the migration flows and to foster the adaptation by the resettled population of techniques adapted to the new ecological context. The global

result has henceforth been an economic failure, and contributed to a new kind of population and environment mess, created by an unsuitable "development" policy.

To escape the failures linked with the oversimplistic approach of an immediate relation between population and environment, one has to shift toward a more complex approach, and recognize the interdependent linkages between population, environment and development processes, embedded in specific social and cultural contexts.

If at the world level, a mechanistic exercise about projections and sheer numbers does provoke sometimes apocalyptic comments, they have no explanatory power at the regional level, where a simple would-be causation between population growth and environment destruction does seem irrelevant (Thiltges & Tabutin, 1992). There is an urgent need for an improvement of basic knowledge about the linkages between ecosystems, cultural and social systems at the relevant level of their interdependence which can be often different from the administrative units or economic regions taken in traditional development approaches for data collection.

Such relevance of a regional or even local framework of study has been given an increasing attention by what may be called a "pragmatic approach". This regional level of integration is seen as a way to escape abstract macro-level linkages and arbitrary segmentation of sectoral problems. Population and environment are henceforth tackled at the level where they are interlinked through the numerous intricacies which shape the development profile of a region. These pragmatic approaches take in consideration numerous different aspects of development: evolution of the agrarian systems, water and forest resources management, the links between regional poverty and migrations, urbanization problems and living conditions of urban populations, etc. (Loriaux, 1990). The pragmatic approach provides a way to escape from oversimplification, because it is often oriented to a "problem solving approach" at a more local or regional level: at that level "global theorizing" about the virtue of "going global" appear of a more limited relevance. A problem solving approach does require the recognition of the complexity of the reality and cannot satisfy itself from "hyper-global" theorizing.

People who are involved in development projects, programmes or policies do need some analytical instrument at a level suited for action, and this at the same time provides a methodological solution. Action is finally always involved in some sort of local or regional context, where one has to tackle the complexity of the relations between economy, society, politics and culture which together shape a certain type of development process in a specific spatial and historical context. All those aspects contribute at the same time, to shape the actual framework of integration between population and environment problems.

So, action-oriented research contributes also to solve the methodological question. One needs an interdisciplinary or even transdisciplinary approach to explore the complex interlinkages between population and environment (Peemans, 1992c).

An even more important aspect of such an approach is that action is no more restricted to the work of development specialists or even field experts. At the local or regional level, population can not be reduced to the "magic of the numbers", or to a sole instrument of a demographic policy. At that level population has to be recognized also as "people", which means as potential or actual actors of a development policy which could enhance a higher qualitative equilibrium between the conditions of reproduction in the long run of a given population in a given environment. In that perspective,

demographic problems are part of the development dynamic of a specific population in a given territory, with its own features and historical identity. They have to be seen as a part of the numerous problems which have to be tackled and discussed by people themselves. They are a part of a decision process, in order to enable these people to define the future path of their own development in a particular context they are the most able to understand and master.

One has therefore to multiply case studies about the actual integration of population, development and environment in regional or local contexts. One has to look carefully at the ways a local "eco-social-system" reflects the impact of more global problems, and one has to assess its own dynamics of change, improvement or crisis. One has to pay attention to the role played by social actors at the level of a region, be it a macro or a micro-region, in the actual integration of population, environment and development problems. One has also to evaluate the main features of that path of integration (or absence of integration) in relation with some sustainability criteria.

Recent local studies have tried to make such an assessment for different regions, especially in Africa. This has been the case, for instance, of insightful explorations of the links between population, environment and development in the Sahel region. In the past, the Sahel has been often the victim of a simplistic diagnosis of environment degradation linking degradation only with the consequences of rapid increases in human and animal populations and with extensive agricultural practices. In reality, it is the result of very long-term processes which affect both society and nature. Its study requires an interdisciplinary approach at different spatial levels (global, regional and local) and with different time scales.

Actually, environment degradation is linked with regional migrations, which reflect problems in the region of emigration and create new ones in the place of destination. Migrants are transferring practices entailing ecological degradation from saturated areas to new "pioneer fronts" where the population density is lower (Mathieu, 1992).

Sahelian countries are in a difficult transition period, where former extensive practices are no more suited to the new social conditions, but at the same time the change toward more intensive practices is hampered by many intertwined elements: the break-up of large lineages diminishes the capacity to mobilize an important labour-force, and there is a lack of appropriate technologies which could lead to a progressive and endogenous adaptation of a more intensive agriculture. Therefore, many peasant households shift toward substitution strategies, by acquiring private land in "pioneer fronts" in order to anticipate the increasing scarcity of land.

In Burkina Faso, the institutional aspects play a large role in the relation between population growth (be it natural or through migration) and environment degradation. When former communal or extended family type institutional arrangements are disappearing, under the pressure of outside events (like the introduction of unrealistic "modern" land laws), there is a shift from a relatively intensive type of agriculture, respectful of the long run equilibrium of local ecosystems, to a more extensive and more predatory type of agriculture, which exhausts soil and natural resources. But these practices are the result of adaptive and rational behaviour by the peasants, at the individual level, under the pressures of increasing constraints resulting from social and economic transformations. Peasants and shepherds have no power to impeach

these outside elements. In order to adapt themselves, "they have to destroy their environment in order to delay their own destruction" (Mathieu, 1992).

This tendency toward extensification is linked with an accelerated trend toward land privatization, absentee landlordism, social differentiation and polarization and the appearance of landless peasants. Land rights insecurity is linked with that changing social and economic context, and contributes to impede intensification in a private and a community level framework.

The need for going farther than a simple mechanical "carrying capacity" assessment to understand the relations between population and environment has been illustrated also for Central Africa, with the multiplication of small-scale sub-regional studies. For instance, it has been recently demonstrated that in some micro-regions of Burundi, the so-called type of Boserupian path is linked with an increasing rate of commercialization and of non-farm activities in the total family income. A more intensive use of the labour force is not linked with the use of new techniques, and the improvement in terms of income does depend upon the shift toward a new mix of cash crops adapted to the evolution of relative prices and markets. This type of adaptation by trial and error does seem to be a defensive strategy. Peasants do not want to take undue risks which could destabilize the conditions of reproduction of the family farms in the long run: performances are not linked with the structures of the exploitations, and the peasant economy does not want to maximize gains, but to reach "equilibrium levels" for basic food and money requirements. Peasants try to resist the dominance of the market, and they want to keep their autonomy, but that resistance, combined with insufficient or unadapted efforts made to support the peasantry, is leading to growing bottlenecks and food insecurity (Verhaegen & Degand, 1993).

Such local studies demonstrate the extraordinary complex web of dynamic interlinkages which have to be understood in order to assess the population-environment problem in a given region. They point also to the need to look at population not as a simple variable, but as an actor of change, with all the features of rational and strategic behaviours. Change in family structures, man-land ratios and migrations are influenced by deep structural constraints and by adaptative behaviours of populations embedded in a specific context. All together they have a huge impact upon environmental change, which in turn affect the future of structural evolution and its consequences upon adaptative behaviours.

## **6. The Need for New Linkages through a "Substantive Development" Approach**

If at world level, mass poverty in the southern hemisphere can be associated with increasing negative consequences upon the environment (Brundlandt Report, 1987), at the regional and local levels, actual observations show that there is always some intermediary societal or cultural behavior which will play a key role to give the specific answer of a peculiar population to an emerging constraint or problem and therefore contribute to the shape of a specific relationship between population and environment. One has always to raise questions about specific social, economic or political elements which have led in specific contexts and specific historical conditions to a peculiar type of relationships among cooperating or competing social actors. Their rational and

strategic behaviours are embedded in such contexts, and are an unavoidable part of intricate population–environment problems.

This leads us to recognize the need for a more substantive approach of the relations between population, environment and development. "Substantive" here has simply the well known meaning given by Polanyi and Arensberg (1957), rejuvenated by recent discussions about the concept of "embeddedness" (Granovetter, 1985).

Progress toward that substantive approach has to be made at different levels. At the methodological level, a systemic approach of the integration between the three fields can help to link global, regional and local aspects of the needed articulation. Propositions inspired by the "theory of the hierarchical integration" have made some recent contribution in that direction. According to these propositions one has to distinguish four stages in the integration process, with each stage representing a step forward in the direction of a more open definition of the development concept and a more active involvement of what is called population.

In the first stage, the "technical integration stage", population is looked at as "the demographic variable" of "economic development programmes", in the most traditional fashion of the mainstream approaches inspired by the modernization theory.

In the second stage, the "scientific integration stage", population studies are linked with a more open definition of development, and one has to try to show the diverse types of interplay which can link population changes and development processes.

The third stage, the "political integration stage", utilizes the results provided by the second stage, but tries to combine the possible scenarios of evolution with the "political projects" of a particular society. Those projects depend on the type of interaction which exists between the state and some sort of coalition of social actors who can influence the definition of the development pattern in one way or another.

The fourth stage, the "human and social–cultural stage", is rooted upon the results and realities of the previous ones, but looks at the population explicitly as "people", men and women, citizens, who have to participate actively in the definition of the development process as actors and not as objects, mass or variable (Loriaux, 1990).

Going from one stage to another, does mean at the same time less global–universal models and more local–regional models, less single causality and more systemic approach, less quantification but more need for a qualitative approach.

Systemic approaches have however to be completed by an historical perspective, and to evolve toward some sort of "historical systemic approach". Simplistic propositions for integration, inspired by different versions of the modernization paradigm, have always been rooted upon truncated interpretations of history. The "take off" interpretation of the British Industrial Revolution, the various theories about the "European model of demographic transition", the dualistic model of interpretation of the "Japanese and East Asian miracles" are all based upon reconstructions of past history, which have been very much questioned in recent years (Peemans, 1992b).

Another perspective upon history is playing a major role to disentangle the narrow minded approach of the modernization framework. It can offer new perspectives upon long–term dimensions of articulation of different sub–systems in a specific development process.

A fresh sociological approach to population problems is also required to foster new ways of substantive integration between the three fields. This means that behind numbers and trends, one has to recognize they are living people who have to be looked at as social actors with some purpose in their action. That would lead to the recognition of the importance of values and culture as key components of an overall approach explicitly embedded in a specific historical context. In that perspective, the search for integration between population and development is deliberately action oriented. An "action oriented holism" would give another meaning to the need for interdisciplinarity.

The ultimate goal is to help people to elucidate the conditions of their greater participation in the decision making process, which can affect their lives and the development path, at the local and national level (Gerard, 1993). That perspective has been reinforced by the new reality of the 1980s which has seen the multiplication of initiatives taken by populations at local level for survival, or even in some cases toward new forms of organizations to try to promote a better life.

These experiences provide new references to seek other substantive linkages between population, development and environment. Development is henceforth seen as the increasing capacity to consolidate and improve social relations inside communities within a given territory (Hettne & Friberg, 1988). It is linked with the capacity of those populations to manage their natural environment in a sustainable way, through the construction of a given territory with an appropriate institutional framework and through the promotion of its cultural identity (Wade, 1988). Some authors are going as far as saying that development is linked with an increasing diversity of development paths, respecting the multiple types of interlinkages which can exist between diverse populations inside diverse ecosystems (Chambers, 1988). In that perspective of "development from within" one is shifting from the concept of "modernizing state" to the concept of "an enabling state" (Taylor & Mackenzie, 1992). There is a need for a redefinition of the relations between the state and local territories in the direction of the empowerment of the latter (Friedmann, 1992).

A substantive approach of integration between population, environment and development does therefore need to pay special attention to the institutional framework. This for instance has a crucial importance in the question of land use management in Africa, with multifaceted consequences upon population-environment relations in Africa.

In the modernization school view, traditional land use systems are an obstacle to development, whereas a modern land use system, favouring private land ownership, would stimulate it (Hesseling *et al.*, 1993). Recent studies have however shown that land right securization has not to be interpreted solely in the direction of individual ownership of the land, which, in some cases, could even be counterproductive, for instance in the Sahelian context. The ongoing development process in Sahel reflects growing tensions among different social actors. Some social groups, generally the "better off", do favour privatization, but others, generally the unfavoured ones, like women, try to assert their rights through new types of collective rights established through new forms of voluntary associations.

It would be constructive to recognize that diversity of social demand. The institutional setting would have to be sufficiently decentralized to allow local communities to find

appropriate land rights arrangements (Hesseling *et al.*, 1993). That could entail positive consequences upon the relation between population and environment through a better control of people upon the conditions of their development at the local level. To contribute to foster the drive toward a labour-using intensification, a consolidation of land use rights has to be flexible and adapted to local contexts (including the right of access to land to all local actors) and to establish a proper equilibrium between private and collective land use, in order to ensure the same security which was provided by traditional land use practices (Mathieu, 1992).

## 7. Conclusions

Recent contributions from counterpoint as well from pragmatic tendencies show a common concern to give great importance to the study of complex interlinkages, which can, at the local and regional level, influence the relationships between population and environment. These relationships have to be tackled in a dynamic and historical approach which shows how global environmental and population problems can actually be understood at a more relevant level for an action-oriented research. That approach focuses upon the interplay between institutions, economic and social structures, and even culture in appropriate space and time settings. There is also a common recognition that populations have to be looked at as actors for the search for an improved balance between people and environment.

Almost all the studies point to the need to consolidate or improve the regional and local institutional framework, through a greater decentralization, to allow local people to have a better control of the local environment. According to that perspective, the state has to support the development of territories by helping local communities to organize themselves through decentralized forms of democratic planning and through appropriate rules, price policies and tax incentives. In the field of rural and agricultural development for instance, this could help to diffuse techniques able to promote an "ecological style of intensification" which requires an appropriate institutional framework, at the community level, to succeed (Peemans, 1992a). Combined with an adequate effort in the field of education and formation, this could give greater security to local communities and favour the adaptation of techniques conducive to greater agricultural intensification and to better environment management and also generate employment and incomes in the local context.

Such a convergence does point to the fact that a positive integration between population and environment does depend upon an appropriate "style of development". It is in line with recent evolution in development thinking (Peemans, 1993). The evolution since the end of the 1980s has been toward a reinforcement of doubts cast since the 1970s about the way modernization theorists discarded the so-called traditional societies as immutable and stagnant. There is a drive toward recognizing the vitality and creativity of "always evolving traditional" societies when studied in a more relevant regional or local framework and proper historical context.

A more open vision of development, than the dogmatic views provided by the modernization or neo-modernization schools can help in that respect. Another view of development is a crucial element, once it is recognized that the dominant model of

growth at the world level plays a decisive role in environment degradation and that it cannot therefore be a credible perspective for the future.

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## CHAPTER 7

# ANALYZING THE ROLE OF POPULATION PARAMETERS IN SUSTAINABLE NATIONAL DEVELOPMENT AND OPTIONS FOR INFLUENCING THEM

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This paper will present an operationalized analytical framework for studying the impacts of alternative population trends on socio-economic and environmental factors. This Population-Development-Environment (PDE) approach has been developed for a UNFPA-sponsored project on population and sustainable development in Mauritius, which recently resulted in a piece of software and a book (*Population-Development-Environment: Understanding Interactions in Mauritius* (W. Lutz, Ed., Springer Verlag, forthcoming) from which this paper largely draws. With some modifications the model can also be applied to other countries. The following points will be based on the analytical insights and empirical results gained from the Mauritius study, which is the first and only of its kind so far. At the end we will also look at policy priorities that follow from this analysis.

The paper is structured in six sections:

- First, the population parameters, which are considered relevant for the study of PDE interactions, will be discussed. In addition to the genuine demographic variables, levels of education and labor force participation will be included as additional highly-relevant, population-based variables.
- Section 2 discusses how population parameters should be related to economic and environmental aspects. Here the basic philosophy and structure of the PDE approach will be introduced and discussed.
- Section 3 then considers the question of the impacts of declining fertility on society, economic and environment in broad terms as well as in the specific case of Mauritius, which experienced the world's most rapid national fertility decline around 1970. This is also illustrated through hypothetical scenarios calculating what would have happened if fertility had not declined.
- Section 4 looks into the future and summarizes the major prerequisites for sustainable development as derived from the Mauritius case study including issues of water supply, agricultural and industrial production, tourism as well as population and labor force. It also addresses the dependence on global economic and environmental changes.
- Section 5 addresses policies and considers broadly the question: What triggered the rapid fertility decline in Mauritius? From this some important lessons about the determinants of fertility decline can be learned.

- The final section discusses policy priorities for the future, concluding that the most important priority under longer term development criteria is the investment in human capital with special emphasis on the status of women.

## **1. Population Dynamics Including Education and Labor Force Participation**

Figure 1 gives some general aspects of the relationship between input and output parameters in a population model for a case that considers only age, sex, and place of residence. Only certain characteristics of the population have an effect on the economy and the environment. The basic characteristics are total size, growth rate, density, age distribution (including mean age and demographic dependency ratios), sex ratio, and regional distribution of the population. These supposedly relevant characteristics of the population, however, cannot not be influenced directly but only through changes in one of the three basic determinants of population change, namely fertility, mortality, and migration.

The effects of changes in fertility, mortality, and migration on population characteristics are not always immediate, but they follow the laws on population dynamics. Even a drastic food shortage or certain epidemics do not directly diminish total population size but work through age and sex-specific death rates, and to some extent also fertility rates, that are applied to the given population structure. Different structures may lead to different numbers of people dying. This dependence on the age structure is still more obvious in the case of fertility where a rapid decline in age-specific fertility rates for instance is applied to a very young age structure of the population. It can take quite a while until it results in significantly declining growth rates. This is the momentum of population growth which can be nicely illustrated in the case of Mauritius where fertility in the late 1980 was already below replacement level but the growth rate of the population was still above 1 per cent per year. The simple reason for this was that more and more young women that were born during the high fertility 1960s entered the prime childbearing ages.

The population module of PDE model as described below can be used either independently to study population dynamics by age, sex, education and labor force participation or as an integral part of the PDE model. It represents a summary of the most important aspects of population dynamics with respect to the four basic dimensions of population structure (age, sex, education, labor force participation) that are considered relevant for any interaction between the population and its environment.

There is no space here to summarize the huge demographic literature on these four dimensions of demographic structure and change. Instead the population module will be presented here as a proposed basic demographic model including the essentials that a demographer would consider appropriate. Certainly there are many other important demographic dimensions, most notably marital status, marital duration, parity, household composition, etc., but we assume that few demographers would challenge the choice of those four dimensions.



Mostly two criteria for the distinction between educational groups can be found: a distinction by reading and writing skills (literacy) or by years of formal education completed. The usefulness of the two approaches depends on the status of the specific population in the process of social development. In an industrialized society where almost everybody can read and write the distinction by formal education is much more useful, whereas in a country with still large proportions illiterate, reading and writing skills are the most important criterion. In the case of Mauritius where already in the 1960s large proportions of the population were literate it was decided to distinguish between primary, secondary and tertiary education. For another application of PDE this could well be different.

Labor force participation is probably the least self-suggestive of the four dimensions considered. It is a dichotomous variable that indicates whether a person is part of a labor force or not. Generally this is defined as a population based measure that is independent from the question of actual employment. Hence the labor force includes all people who are actually working (including those on sick or maternity leave) and the unemployed. Somewhat loosely one can say that the labor force consists of all people that want to work. Obviously the numerical measurement of this also depends on national definitions, that may differ from one country to another. For example a housewife who is theoretically willing to work but does not take any concrete steps for finding a job because she considers it hopeless and does not register as unemployed because she is not entitled for benefits may be considered as part of the labor force in some cases and as outside the labor force in others. But despite these problems of definition, major changes in labor force participation rates still indicate major social changes that have significant impact on the economy at various levels, as we will see in the economic module below.

One prominent demographic variable that is omitted in this population module is marital status. Because marriage is still closely related to fertility in most countries of the world changes in marriage patterns have immediate consequences on birth rates. This is also true for Mauritius where it was demonstrated that the rapid fertility decline in the late 1960s and early 1970s was to a significant extent due to increases in the age at marriage. But despite this explanatory importance of marriage it is here of interest only as an intermediate variable influencing fertility and not in its own right as it would be for instance in social security considerations. For this reason it was decided not to specify marital status as an independent variable but be aware of the fact that all scenario assumptions on fertility include the marital status dimension.

Considerable attention was also given to the question whether household size and structure should be explicitly treated in the model. A strong argument in favor of this is that private consumption patterns are usually defined in terms of household consumption and not individual consumption. There is, however, no feasible way to convert information based on individuals (such as given in the chosen form of the population module) directly into information on households. Even if these two different aspects could be matched for the starting year there is no way to guarantee consistent changes in both when patterns are projected into the future. For this reason the population module will stick to the individual as the unit of analysis and in the economic part, consumption patterns will also be defined on an individual basis.

The traditional cohort component method of population projection is only designed to forecast populations by age and sex. If we want to include the two additional

dimensions education and labor force participation we must refer to the tools of multi-state population projection. This method was originally developed to simultaneously consider and forecast populations in several regions that interact with each other, i.e. in addition to giving birth to a child or dying, people can also migrate to another state at any age and any time (Rogers and Willekens, 1986; Keyfitz, 1985; and many others). This methodology, however, is not limited to the analysis of geographical regions. It can also be applied to different population groups living in the same region be it marital status groups or educational groups, or groups defined by any other criterion.

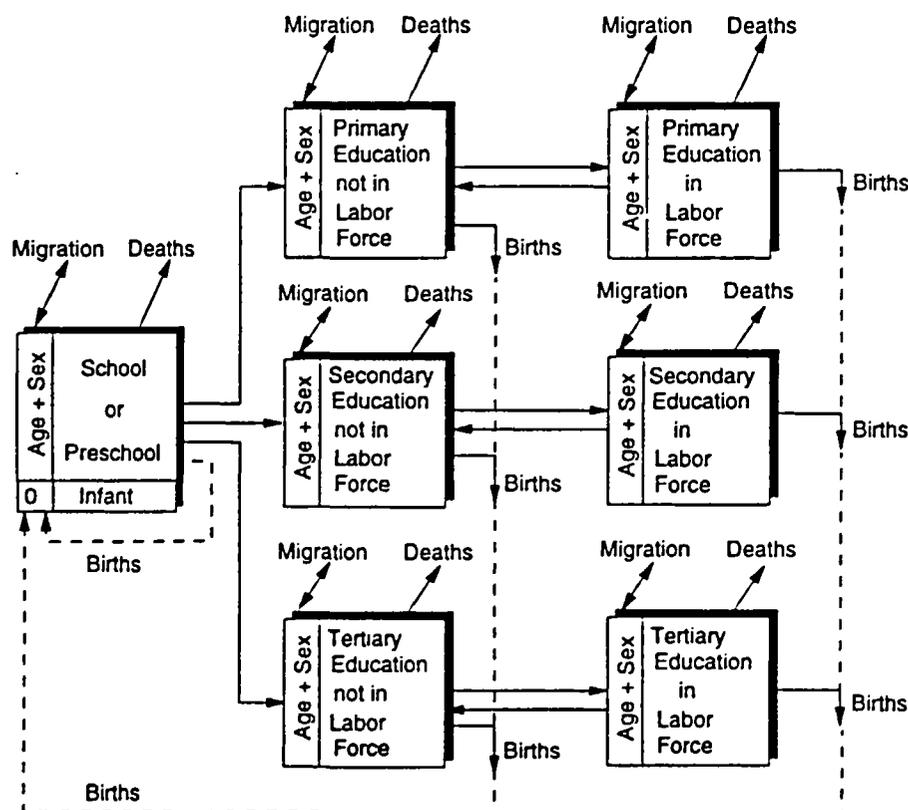


Figure 2. Basic structure of the population module with seven states for women. For men it is identical except for births.

For the purpose of breaking down the population by education and labor force participation, seven states have been defined as shown in Figure 2. The first state to the left includes all children and the total population in school or university. All newborn start in this category. When leaving school they go to either the population with some primary education or to that with some secondary or to that with some tertiary education and in each of these categories they either stay in the group that does not participate in the labor force or that participates in the labor force. The age- and sex-specific rates at which men and women move from one group into the other are based on empirical data for the starting year and subject to scenario specifications for all years thereafter. Multiple transitions within one time period—which is 5 years in the case of PDE– Mauritius—are possible. For instance someone may leave school, enter the group with secondary education not in the labor force, move on to secondary in the labor force and go back to not in the labor force within a five year period. Within each

group women have children according to the schedule of age-specific fertility rates that can be defined separately for each group and that may change over time according to scenario specifications. The newborn children do not enter the group of their mother but all start at age zero in the group of children and students.

In addition to the possible transition to another group--where the model is semi-hierarchical because not all transitions go in both directions--people can leave the states by either emigration from Mauritius or death. New people may also enter the states by immigration. Age- and sex-specific death rates can also be defined separately for each group. Because of the lack of empirical information on differentials in these rates, however, the default in the program is identical mortality rates in all states. Migration is specified in terms of absolute numbers and assumed to differ substantially with educational groups, with the most educated showing the highest mobility.

Most of the effects of population size and structure on the environment work via the economy: higher education directly increases labor force participation; consumption is made dependent on educational level and age; the supply of labor is given by educational groups; and government expenditures are directly dependent on the age structure (pensions, health, and educational expenditures). There are also direct effects of population size on the land use module with respect to land demand for housing and on the water module with respect to gross water intake by private households.

## **2. The Population Module Embedded in the Economic and Environmental Spheres**

Formal models on computer are a tool to support the human brain. In the same way that a pencil can help the scientist remember his present thoughts, a computer model can help the scientist consider simultaneously more variables and interdependencies than he could manage even with a well-trained mind. Because population-development-environment interactions are highly complex, a non-formal, non-computerized analysis such as that presented in the previous section can only sequentially describe relevant aspects and discuss interactions one after the other. This approach may be appropriate for understanding the history and describing the course of events that have already taken place and that will not be altered by the model of the scientist, although its interpretation may well be altered. When attempting to project possible future trends, on the other hand, the simultaneous consideration of all important interactions between the variables is absolutely essential. Any one-dimensional projection of a trend that disregards likely influences of other variables is bound to be wrong in the sense that reality will be different. Hence, at least for the future we need to use computer modeling to combine and evaluate complex sets of assumptions about individual variables and specific linkages. Despite its superiority in many aspects to a purely mental model, a computer model will always be far short of an exact representation of reality. The best thing one can hope for is to capture the most relevant aspects of the system.

Any design of a model includes difficult choices of variables and assumed mechanisms. The results of the model will crucially depend on those choices. The

challenge for our attempt to design the PDE model was to be as broad and flexible as possible in the basic (hard-wired) structure of the model and stick to unambiguous relationships which can hardly be debated even by scientists with greatly conflicting views. In the "soft" part of the model, which is operationalized through the tools of scenario setting, all the less straightforward and controversial linkages may be defined. A comparison of the outcomes of alternative specifications then can help to better understand the system and put into perspective differences in opinion expressed in the literature.

In short, the PDE model is a flexible and user-friendly computer tool to better understand the relationships between population change (P), socio-economic development (D) and environmental factors (E). It gives a broad accounting framework which quantitatively specifies the most important and immediate effects of some sectors of the system on others. It is flexible in the sense that the user is free to choose different values for a large number of parameters, and to define any combination of possible trends and policies--as well as feedback mechanisms--through the tools of time-dependent interactive scenario setting. The PDE model aims at enhancing scientific understanding and demonstrating the longer term consequences of alternative policies or external developments. It has no immediate advocacy purpose.

When discussing the philosophy and basic structure of PDE models, it is important to distinguish between the general PDE approach, which could be applied to other countries or regions, and the specific form of PDE-Mauritius. The latter was made to fit specific Mauritian conditions ranging from the climate to economic structure, data availability and time constraints in the completion of the model. The Mauritius model should be seen as a first attempt and a prototype of a PDE application.

The first letter in PDE refers to population, the second to development and the third to environment. This sequence is not arbitrary; it expresses the basic philosophy of the model. Population is taken as the point of departure as one of the basic driving forces that--together with many other factors--has an impact on development within environmental constraints.

Frequently, scholars addressing population-environment issues tend to view them in terms of two independent boxes (see Figure 3) with a causal arrow between the boxes. While the population box can be defined as a distinct entity (the number of people in a certain region), it is usually unclear what the environment box should contain. It might be one very specific aspect of environmental change, such as deforestation or air pollution. But generally the environment must not be represented by an independent box for two reasons: First, environment and the laws of nature are everywhere and no line can be drawn around nature; second, nothing is independent from the environment, including the human population that is part of nature and in all basic life-supporting functions depending on the environment.

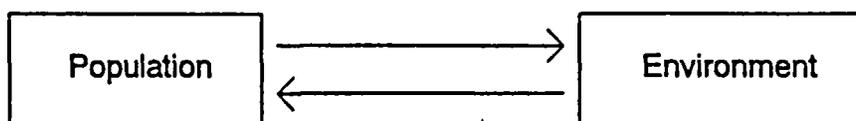


Figure 3. A misleading "box approach" to studying population and environment.

Rather than viewing population–environment linkages in terms of a linear causal chain, it should be visualized as a series of concentric circles where the sphere of development, i.e. the sum of social, economic and cultural activities, is intermediate between the demographic aspects of the human population and the natural environment (see Figure 4).

Every life on earth, every economic activity, and any kind of development are embedded in the laws of nature. Hence at every stage, they are intimately interwoven with the natural environment. In this sense, the environment should not only be seen as a constraint, but also as the basic life support system that makes all human activities possible. It is simply impossible to think of economic activity as being independent from the physical environment. The reason why most economic models do not explicitly consider the environment is that such models have a limited scope and for the models' specific purposes, environmental variables have been considered irrelevant.

No serious person could deny that without the air to breathe, or without such resources as sufficient water, energy and raw materials, any economic activity would be impossible. These basic life and economy supporting factors were assumed to be in abundance and were therefore omitted from the equations. This is a legitimate simplification, if these assumptions are true. However, environmental constraints have become more visible recently and, accordingly, economic models must begin to include these factors in order to be considered relevant representations of reality. There is no doubt that economic activity and development are, at every point, subordinate to the laws of nature, and it is for this reason that Figure 4 shows population and development to be entirely embedded in the environment.

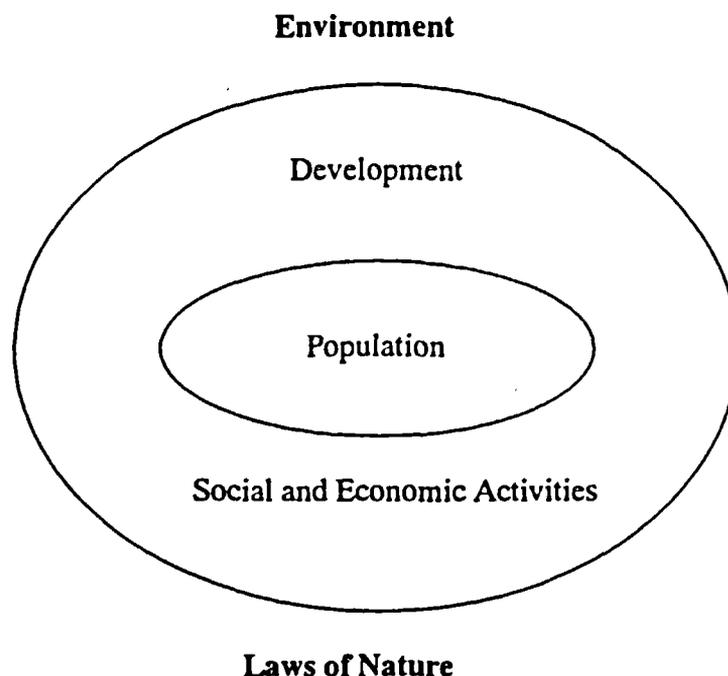


Figure 4. Population embedded in a socio–economic sphere and in environment.

Within the sphere of development and economic activity, people are the agents. They are the ones who conduct the activities, develop routines, traditions, cultures, knowledge and infrastructure. These economic activities are necessary for human survival. Again, there is no doubt that any human life is dependent on certain forms of social and economic activities, and that further development of these activities makes life on earth possible for a larger number of people. This is why the population is constantly embedded in the sphere of development, along with social and economic activities. However, it is also clear that the demographic characteristics of the population are not the only determinants of these activities. It is mostly such qualitative aspects of the population as human skills and knowledge, along with accumulated infrastructure (capital) and the sum of environmental influences (traditional production factor "land"), that determine development. In the long run, the human resource factor (human capital in its quantitative and qualitative aspects) seems to be the most relevant for development. For this reason PDE assigns population a key role in the analysis of development within the ecosphere. Certainly, there is a large number of significant other factors that influence development, which are specified as exogenous and endogenous variables in the economic module of PDE.

The environment is everywhere; but how should it be meaningfully captured in a quantitative model? Most of the analyses which claim to consider the environment in the context of development select one or two very specific aspects of the environment, be it CO<sub>2</sub> emissions or rates of deforestation. These specific analyses can be useful as illustrations for certain impacts, but they cannot claim to capture comprehensively development-environment interactions. A lot of attention is currently being given to carbon emission, because of the fear of climate warming, and to the level of CFCs because of the ozone layer. Tomorrow, however, new environmental priorities may come up, such as immediate problems of water supply, toxic waste, radiation or possible new and untreatable diseases. Because such a disjointed and fractional approach to environmental questions could turn out to be rather short lived--hence missing some of the more important interactions--the PDE approach attempts to be as holistic as possible by, at least in theory, giving attention to all possible environmental aspects.

When thinking of how to find a meaningful differentiation of the environment as it relates to human life on earth, it can be instructive to go back to the very origins of occidental thinking in ancient Milet, around 600 B.C. There Anaximander, who had supposedly drawn the first map of the world, claimed that four elements--water, air, fire and earth--made up the world and stayed in some kind of balance. These early attempts to understand nature and the environment of people may also be useful in structuring our thinking in how to identify relevant environmental aspects for the modeling of population-environment interactions. Water, air and land can readily be taken as environmental subsystems that deserve special treatment and will be described by separate modules in the environmental segment of PDE. Fire can be interpreted as energy that is also worth separate treatment. Another environmental system which is not mentioned by Anaximander is the sum of living species on earth. For our purposes it is useful to distinguish between the human species, the population, and other species with special attention to the change in biodiversity.

When attempting to translate these general ideas into an operational quantitative model for the computer, a large number of specifications and definitions are required.

In this we tried to follow three basic principles of modeling which we had chosen for the PDE approach:

1. The model should only include relevant aspects which could potentially make a difference in the specific case considered.
2. The model should be as simple and straightforward as possible, avoiding 'magic' black boxes.
3. Only unambiguous and direct relationships should be hard-wired in the model. All other aspects should be treated as part of the soft model structure, as expressed by scenario settings.

While there is little new about the first two principles, the third may need some explanation. Our approach here is based on one of the lessons we think we have learned from the global modeling of the 1970s and early 1980s. The system should not become an artificial world in itself which, due to many pre-defined feedback loops, develops its own life and takes off in directions that can hardly be followed by common sense and have little to do with reality. We wanted to avoid hard-wired unchangeable feedback loops that are based only on ambiguous theory and scattered empirical evidence.

An example of this is the question whether fertility and mortality levels should be made direct functions of any other demographic, economic or environmental parameters in the model. Because the vast literature on socio-economic fertility determinants does not suggest any clear and simple functional relationship between fertility and a set of non-demographic parameters, we decided not to specify such a relationship when it could hardly be defended. Instead, the user can decide when and how in the course of running the model the fertility levels in the different population groups should be changed, based on either altering socio-economic or environmental conditions, or simply on assumptions about relevant cultural and behavioral change. This possibility of user-defined feedback through scenario assumptions is called the soft model, as opposed to the hard-wired, predefined hard model. With respect to fertility, there are also several hard-wired aspects which work through the changing educational composition of the population. If the user assumes different fertility levels for different educational groups, a change in the educational composition of the population--which is also influenced by economic and government policy parameters--has a direct impact on the average fertility level in the population. This is a simple consequence of changing weights. Similar distinctions between hard and soft parts of the model can be found for many different sectors of the model.

Following these general thoughts, Figure 5 presents a model proposed as a general guideline for the PDE approach. At the center one finds the population broken down--in the first instance--by age and sex. This gives the traditional age pyramid with men (on the left) and women (on the right), with the lowest age group at the bottom and the highest at the top. Although some models deal primarily with total population size, we believe that age structure, in particular, is an essential feature of the population which has immediate effects on the economy and society. Furthermore, over time, disregarding the population age structure would make it impossible to capture the momentum of population growth which--in most less developed countries--is quantitatively an extremely significant phenomenon. The growth rate of the population can only be indirectly affected through fertility rates, and with the population structure

exerting momentum. As will be shown in the following chapters, Mauritius gives a good illustration of this point.

As discussed above, age, gender, education, and labor force participation are cross-classified in a multi-state population model. This form of the population module seems to be relatively unambiguous, with respect to both substance and methodology. It is an attempt to summarize, in one compact unit, the essentials of population dynamics that can be handed over to the rest of the model for economic, environmental and policy considerations. Parameters of change in the population module are fertility, mortality and migration in each subgroup, as well as schooling and labor force entry and exit.

In Figure 5 the population parameters are embedded at every point in the sphere of social and economic activities, including accumulated knowledge and infrastructure that may be summarized by the notion of development. This includes models of production and consumption by economic sectors as well as imports, exports and domestic trade. Obviously savings, investments, and government expenditures also need to be considered. Finally government policies play a crucial role in all social, economic and even environmental aspects.

Unlike most other similar models, the PDE model does not want to be primarily an economic model. Its emphasis is on the population-environment relationship. But because population factors hardly ever directly interact with environmental factors, the economic module is intended to serve as a linkage between the two. In designing the economic module, one is faced with a dilemma: on the one hand, the philosophy of the PDE approach asks for as simple a model as possible to serve the purpose of linking population to the environment, whereas on the other hand one is in competition with a large number of very sophisticated economic models that do not attempt to provide this linkage. For the Mauritius application, a form of the input-output table has been combined with certain features of general equilibrium models. The final product still reflects the evolution of thinking and development and, although it is functional, it could well be improved for another application. In particular, it may be necessary to reconsider whether the advantages of an input-output table are worth its limitations.

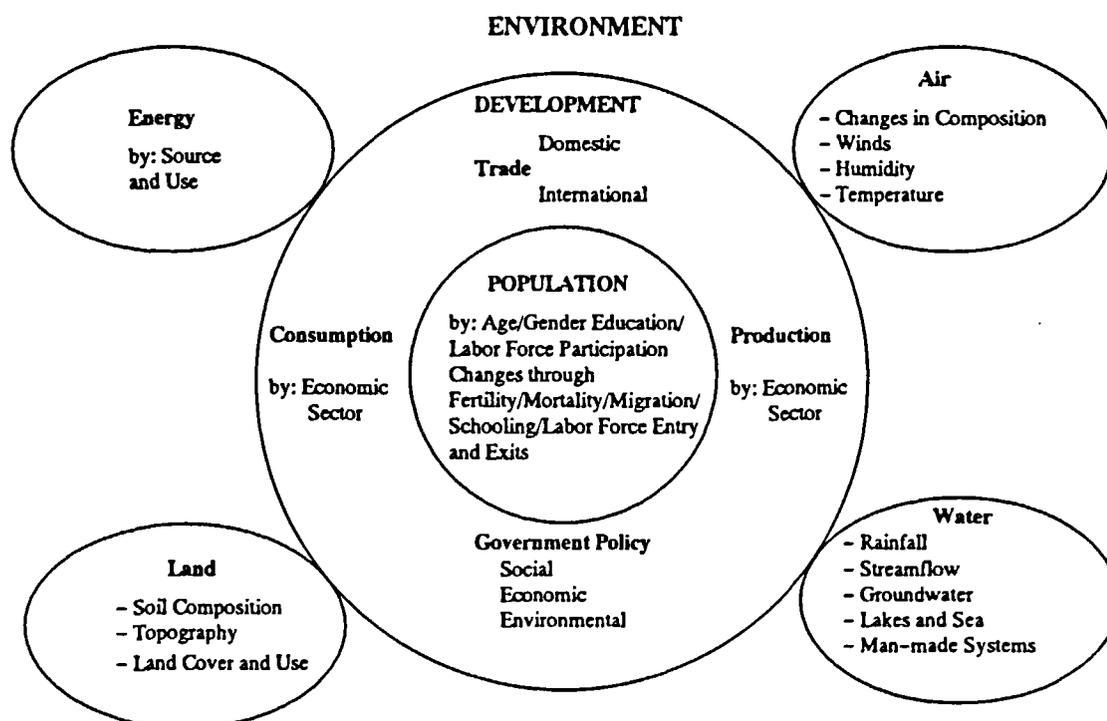


Figure 5. Basic structure of the general PDE model.

But no matter which approach to economic modeling is chosen, certain features should be retained. These are reflected in the Mauritius model, as described below. With regard to the linkage of the economic module to the population module, all of the selected basic population characteristics—sex, age, education and labor force participation—must be reflected in the economic input parameters and must make a difference on the results. In the Mauritius application, age, gender, and labor force participation determine the size of the active population, as opposed to the dependent population (children, elderly, housewives). Higher labor force participation reduces the size of dependent population. The educational composition of the population also has important independent effects on the economy. Firstly, higher education is assumed to increase economic productivity and, as a consequence, the competitiveness on the world market, and lead to faster technological progress. Secondly, consumption patterns are assumed to depend on age and education. Because the population module can only provide such information about individuals that cannot be directly translated into household distributions, consumption is also defined for individuals by age instead of the usual household definition.

Another general criterion for the economic module is that it should consider the major components of the economy separately, in order to allow the analysis of changes in the economic structure. But a model of the world market for relevant export goods (such as sugar in Mauritius) is not being attempted. It would be a very complex task in itself. Instead external factors—such as export demand—will be treated through scenario-defined input parameters. The economic module should also produce some basic indicators of material well-being, quantify government expenditures and investment in various important aspects of infrastructure, education and social security, and provide unemployment figures. Finally, the economic module is expected to produce—as output variables—the input parameters for the various environmental modules. These

would include such parameters as water demand figures, water pollution, solid waste, changes in land use, etc.

Figure 5 finds the environment broken down into four basic environmental sectors: air, water, land and energy. The air module should be concerned with the chemical composition of the air, along with air temperatures and humidity, and the direction, speed and seasonality of winds. The specific aspects and models selected to describe relevant aspects of atmospheric change depend, to a great degree, on the country or region chosen. In urban and industrial areas in particular, emphasis would be placed on air pollution which displays immediate implications on human health and on the health of the vegetation, especially forests. For more global considerations, attention would probably be directed at greenhouse gases along with those gases responsible for ozone depletion. In the specific case of Mauritius, the fundamental modeling principle-- of only including variables that are assumed to have an effect on the outcome--resulted in the decision to omit the air module altogether. As will be described in the following section, the almost permanent winds in the area will immediately transport any kind of air pollution over the vast Indian Ocean. Some minor local air pollution problems, located near sugar mills, did not justify an extensive consideration of air quality questions. We will, however, present calculations on contributions of Mauritius to global CO<sub>2</sub> emissions. The questions of air temperature and humidity, relevant to the water balance of Mauritius, are extensively dealt with in the water module.

The water module is probably the most relevant of the environmental aspects, due to its direct links to human life support systems. Problems with water supply can, in both the short and long term, lead directly to health problems such as those caused by lack of food production or by the consumption of contaminated water. Because most regions have different semi-independent water systems such as rivers, groundwater, lakes, and coastal waters, the water module should consist of several sub-modules that describe and model the dynamics of the systems relevant for life in the specific regions. For each of these subsystems, two important and different aspects of water need to be considered: the quantity and the quality of water. Both aspects are important, and problems with either one may cause problems for the system. However, quantity and quality are not independent. The quality of a given amount of polluted water can be improved by adding clean water. Hence, quantity can solve the quality problem.

Hydrological modeling is a large scientific field in itself. After a review of the relevant literature, the following approach was chosen: The surface freshwater model is basically concerned with the balance of water requirements (demand) and water availability (supply) at a given user-defined minimum water quality standard. Supply and demand for water are specified in terms of physical quantities. The chosen water quality standard, together with the user's decision about investments in waste water treatment, determines the dilution flow component of water demand. In this way, water quantity and quality have been linked into a common system. The freshwater supply is based on information about precipitation, evaporation and historical flow data. The water supply is measured in terms of aggregated minimum flow which the user can choose to increase by investing in storage capacities.

In the specific case of Mauritius, the approach described above was applied, taking the island as one more or less homogeneous region. In other, more heterogeneous, cases

one would certainly have to specify a more complex multi-regional model to account for the possibility of water being transported by rivers from one region to another. For Mauritius the water module also includes a separate module on water dynamics and sedimentation in the lagoons surrounding large parts of Mauritius.

Theoretically, the land module includes all aspects of surface structure, vegetation and soil composition. In cases where soil degradation and erosion are serious problems, appropriate models which describe these phenomena in physical terms need to be chosen. In the case of Mauritius, the land module is mostly concerned with questions of land use and regional distribution which are closely tied to economic changes and the values of different categories of land. This module distinguishes between four major types of land use: urban use (including settlements and industries), sugar cane fields, other agriculture, and beaches which, because of the tourist industry have by far the highest value per land unit. There are also protected lands (crown lands) and hardly usable areas on Mauritius. The land use module reconciles competition from different users, and puts constraints on the economic module and other environmental modules.

The influence of all non-human living things (other species) can be very relevant for the man-environment interaction. This includes considerations of biodiversity as well as the changing distribution of species ranging from bacteria to whales. It is not only relevant for the basic life support systems but also for the disease environment that affects human mortality and partly also fertility. In the case of Mauritius, however, these questions were not considered in the quantitative model because of principle number 1, i.e. changes in other species are generally not considered to make a big difference for Mauritius over the next six decades. Special attention will be given to the corals, however, and certainly the vegetation is considered in the land use module.

Energy, the fourth of the basic elements mentioned by Anaximander, could be treated either as a separate module or as part of the economic module. Because of its close relationship to the economy, it was decided to initially treat energy considerations as part of the economic module. If more sophisticated and independent energy modeling were to be considered desirable, a separate energy module would have the advantage that energy could be treated on physical instead of monetary terms as is done, for instance, by the ECCO models (see King, 1991). The same is true for agriculture, which in the PDE-Mauritius model is considered as one of several economic sectors. In a predominantly agricultural country it might make sense, however, to create a separate agricultural module, possibly in conjunction with the land module.

The specific form of the PDE approach chosen for the PDE-Mauritius consists of four semi-independent modules population, economy, water and land use. The population and water modules can also be used as fully independent models in themselves if scenarios are defined for parameters designed to be imported from other modules. In the specific Mauritian PDE application, the land use module is so closely tied to the economic module that it makes no sense to run the two independently.

### **3. Did the World's Most Rapid Fertility Decline Make a Difference to Economic Development on Mauritius?**

This section deals with the consequences of fertility decline on economic development. More specifically we will look at the following questions: Did fertility decline and the slowing population growth rate exert a positive influence on the start of the economic boom of the 1980s? Does the traditional Coale/Hoover (1958) argument on capital shortage due to many children hold for Mauritius, or were other mechanisms dominant during the past three decades?

On an international level the aggregate empirical evidence on this issue seems to be very mixed depending to a large degree on the choice of variables. In their 1986 report the U.S. National Academy of Sciences presented a summary of recent research on the economic consequences of population growth in developing countries. Most of that report focuses on the question whether slowing population growth is advantageous under certain economic and resource availability criteria. The conclusions distinguish between short-term and long-term consequences. For the short-term the report generally sees beneficial consequences of slower population growth. But for the long run, it stresses the possibility of positive effects of population growth due to incentives for improved organization and technology.

Such general statements on the long-term behavior of highly complex and hardly understood societal and economic systems, however, are largely based on mental concepts with little possibility for empirical support. Consequently the report also concludes:

" In short, the effects of rapid population growth are likely to be conditioned by the quality of markets, the nature of government policies, and features of the natural environment. Since the effects are so dependent on these conditions, a reliable assessment of many of the net effects of population growth can best be carried out on the national level..." (U.S. National Academy of Sciences, 1986:89).

#### **3.1. Fertility, Population Growth and Income**

Figure 6 plots the evolution of three basic variables in Mauritius: per capita income, population size and fertility. Already the timing of changes in those variables can give important indications of their relationship. The first observation on the demographic side is that despite dramatic fertility decline, total population size is rather inert and increases steadily. This is due to the momentum of population growth and the fact that mortality also improved.

Because of the almost linear trend in population size between 1950 and 1990, it is difficult to make any argument directly related to GNP which, on a per capita basis, was almost constant between 1950 and 1970 and then shows two big jumps in the 1970s and the late 1980s. If increasing population size should have induced economic growth, one must make the unlikely assumption that some magic population density thresholds were reached in 1970 and 1985. Based on the Mauritian evidence, it is equally difficult to make the point that total population size was an obstacle to economic growth.

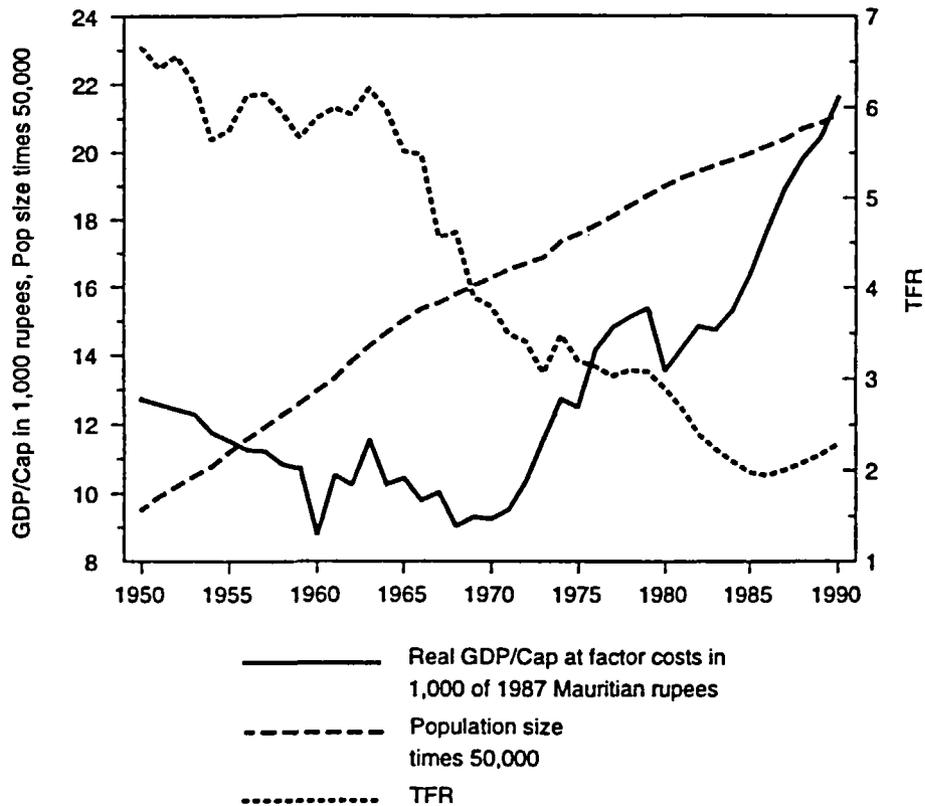


Figure 6. Total fertility rate, per capita income and population size in Mauritius, 1950–1986.

It is much more instructive, however, to study the relationship of income to fertility instead of total population growth, which is quite a different question because of different assumed mechanisms of causation. (Looking at population growth rates would be a mixture of these two aspects.) It is remarkable to see that the first big increase in income followed immediately after the first big fertility decline. The second jump in income followed another moderate fertility decline that brought fertility down to replacement level.

There are important non-demographic factors associated with the phases of economic development. For the late 1980s the introduction of the Export Producing Zone policies seems to be the overwhelming determinant. For the 1970s the external reasons for the rapid income growth are less clear. It coincides with Mauritian independence, with first industrialization efforts, favorable international conditions and stable sugar prices. But the preceding fertility decline may have well been instrumental for this economic takeoff.

We can think of two arguments aside from the Coale/Hoover savings argument that would support a causal effect from declining fertility to increasing income. The first relates to the labor force by freeing young women to work in the new factories instead of being locked at home with children. And indeed, female labor force participation rates in Mauritius increased from 20 per cent in 1972 to 28 per cent in 1983. For young

women (aged 20–24) this increase was even much stronger, reaching 40 per cent in 1983. Mostly in textile factories but also in the service sector, the rapidly increasing young female labor force contributed substantially to economic growth. With traditional high fertility and young age at marriage, this could not have happened. Certainly, to be effective, such a development requires the availability of new jobs for women, which was the case in Mauritius.

The second argument is much broader. It relates to the view that the fertility transition is essentially based on a mental transition, on a change from aiming at quantity of children to quality (skills, higher status). This refers to the first of Coale's basic conditions for a sustained marital fertility decline as discussed above. Some even call it a transition from fatalism to individual rationality. Now the argument is, once individual rational choice has been introduced into one's private life, it is this mental transition that consequently results in longer term investments into the future, including training (of oneself and of children) and economic activities. Such longer term investments on individual as well as on familial and societal levels are also the basis for any economic development. In this sense the fertility decline may be seen as being closely related to a takeoff in economic development.

There are several other countries where the sequence of fertility decline and economic growth is similar to Mauritius (most notably China) but as shown above, the two developments may also be simultaneous or in specific cases (such as some Arab oil exporting states) in reversed order.

### **3.2. What Would Have Happened Without Fertility Decline?**

The PDE–Mauritius model developed for this study allows not only projections into the distant future but can also be used to construct alternative histories. In this case 1962 (a census year) is chosen as the initial state. Thereafter the observed development for 25 years (up to 1987) is reconstructed as one scenario. But several hypothetical alternative scenarios also have been calculated, four of which will be briefly discussed here for a quantitative assessment of the role of population variables in income growth.

Table 1 shows that the observed development between 1962 and 1987 brought a 101 per cent increase in per capita GNP. If no development at all had taken place—i.e. all demographic, social and economic parameters would have remained at their 1962 level—GNP per capita would have declined to almost half of the already very low level by 1987. If, however, fertility had declined and education improved with otherwise constant parameters, per capita income would have only declined by 22 per cent. Hence a fertility decline would have made the bad situation somewhat better.

In the case of assuming progress in the economic parameters along the line actually observed between 1962 and 1987 but without a fertility decline, per capita income would have increased 'only' by 63 per cent instead of 101 per cent, i.e. one-third less. If one also assumed no social development which mostly refers to observed education, GNP per capita would have increased by 'only' 61 per cent, i.e. somewhat more than half of the observed increase.

Because there are many other relevant economic variables such as unemployment, government deficit and trade balance, that develop differently under the various scenarios, the figures on GNP in 1987 demonstrate only part of the economic

consequences of alternative demographic and educational developments. But the directions and the orders of magnitude are clear: Between 1962 and 1987 the exogenous economic parameters had a larger relative influence on income than direct effects of fertility decline that are clearly visible nevertheless. When extending these hypothetical histories to 2002 the negative relative effect of higher fertility and lower education comes out even stronger. The given calculations, however, include only direct "hard-wired" effects and do not include more indirect effects of the kind described in the previous subsection which, under the PDE approach, belong to the "soft" model that is implemented by means of a user-defined scenario setting.

**Table 1. Observed and hypothetical effects of declining fertility under different social (mostly education) and economic scenarios on per capita income in constant Mauritian Rupees.**

	1962	1987	% Change
Observed development	8,958	17,999	+101
All 1962 parameters constant		5,886	-34
No economic development but fertility decline and social development		6,987	-22
Economic development but ... ... no fertility decline		14,620	+63
... no fertility decline and no social development		14,403	+61

In short, there are several reasons to assume that the fertility decline in Mauritius had a role in triggering the subsequent economic boom. Despite the fact that economic and political variables are the most visible determinants of economic growth, the model also shows that without a fertility decline, Mauritius would be clearly worse off today. On a deeper level mental changes associated with the fertility transition may be essential for economic development.

## 4. Alternative Scenarios for the Future

This section highlights some key aspects of the future dynamics of the population–development–environment interactions as derived from the findings of the Mauritius Case Study.

### 4.1. Water as the Basic Physical Constraint Even on a Tropical Island

The international discussion on resource availability has recently given more attention to the management of renewable resources since the concern about non–renewable resources has somewhat diminished. Water is a very special kind of renewable resource because its local availability is essentially determined by the climate and topography, and can only be transported over longer distances under specific conditions. On Mauritius total freshwater availability must essentially be considered as a fixed resource with significant seasonal and annual variations.

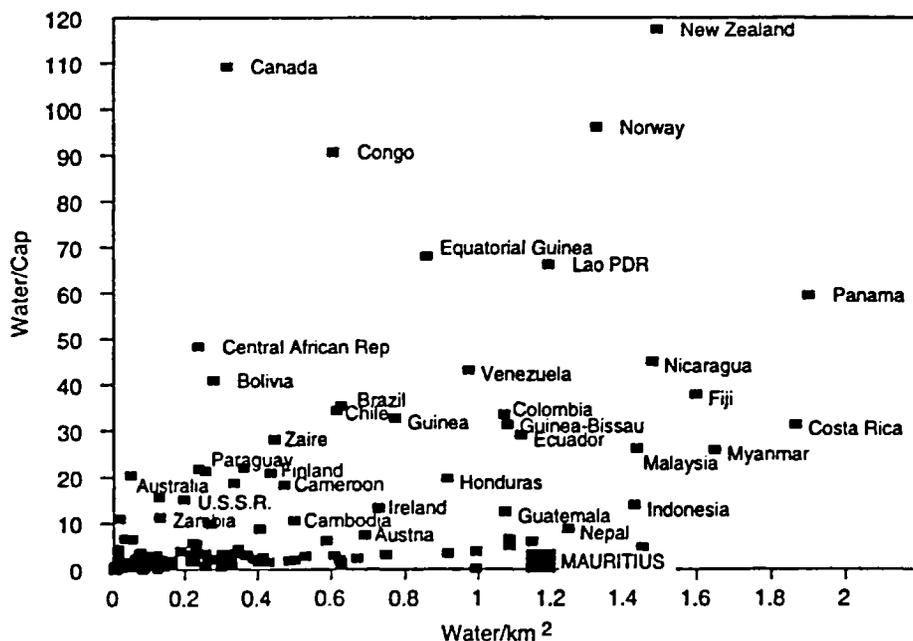


Figure 7. Annual internal freshwater resources per person and per km<sup>2</sup> in all countries of the world (except for five extreme outliers).

Whether Mauritius has scarce or plentiful fresh water resources depends on the point of view, whether we consider water per person or water per land area. Figure 7 shows a cross classification of a number of countries according to these two variables. Mauritius is found in the lower right corner of this graph, indicating that because of its tropical climate and mountains, Mauritius has more water per km<sup>2</sup> than most other countries in the world, whereas it has very low per capita water resources. The discrepancy results from the very high population density on Mauritius.

The set of future scenarios consistently shows that water availability at a given high standard of quality is the essential environmental constraint to unlimited economic

growth on Mauritius. Whether this constraint will actually inhibit economic growth depends on the investment made into water storage and treatment. Under environmental laissez-faire policies together with an export-driven economic boom, the limits will be met relatively soon. But the model also shows that timely investment into water management infrastructure will make possible even very rapid further economic growth. This is especially the case when growth is not based on irrigation-intensive sugar cane but rather on industry and services. Among the many relevant aspects of water management waste water treatment comes out as the most significant.

Another aspect which is considered in the water module of the PDE model is the water quality of the lagoon which surrounds large parts of Mauritius and is an important natural asset, not least for tourism. It also affects the survival of the coral reef which is already partly damaged. It is shown that enforced legislation on water treatment and waste disposal can make a big difference here.

#### **4.2. Future Agriculture and Industrial Production**

Sugar cane has traditionally been the backbone of the Mauritian economy. Sugar fields and sugar factories still dominate the Mauritian landscape. Only in recent years industrial exports (especially textiles) have surpassed sugar exports. Over the past decades sugar prices and quantities guaranteed to Mauritius by the European Community were a very important element of stability during the onset of the recent economic boom in Mauritius. But prospects for the future are unclear if not shaky. Sugar exports to the US have significantly declined due to changes in diet, and it is not clear how the European market, where domestic sugar beet is a serious competitor, will develop. The recent labor scarcity in Mauritius and the general increase in salaries also affect the labor intensive sugar plantations negatively.

Several scenarios have been calculated that assume drastic changes in international sugar demand and domestic factors such as a sugar policy for reasons of tradition rather than profitability. The general result is that it does not make much sense to further intensify sugar growing (which already has a very high fertilizer and irrigation input) for economic and environmental reasons. Sugar refining, however, can be made more efficient especially by using the large energy potential of bagasse. To prohibit the conversion of sugar land for industrial or urban use is neither economical nor practical, but the present land conversion tax that depends on the fertility of the soil is an interesting solution.

Future industrial growth is assumed to be mostly driven by export demand. When staying in the same export market dominated by textiles, per capita income could still grow significantly to about five times the present GNP/capita by the year 2050. Through a structural change in the economy toward higher value added products and especially services, however, economic growth could potentially be even more rapid (following the example of the Asian tigers) and result in income levels by 2050 that are higher than today's European levels. Because of a move toward less polluting and less water-intensive industries, this would also be possible from an ecological perspective. Aside from favorable international conditions one domestic prerequisite for such a rapid and sustainable development is a highly skilled labor force.

### **4.3. Role of Tourism**

Despite the rapid growth of international tourism on Mauritius over the past years, in 1990 foreign exchange earnings from tourism comprised only 15 per cent of the total exports and an estimated 3.3 per cent of the GDP. But there are also important indirect benefits from tourism. Mauritius has made a clear choice for high quality expensive hotels and has put an upper limit on the number of hotel rooms. Because of the limited availability of attractive beaches there is an inherent conflict between private and public access that requires careful management.

In an international perspective Mauritius is still in an early stage of a hypothetical tourist resort cycle (see Debbage, 1991) in which very rapid expansion may be followed by stagnation and even decline because of loss of attractiveness. To avoid an ultimately destructive development such as on the Bahamas, Mauritius must make efforts to regulate and limit the expansion of tourism. The present policy of high cost and quantitative limitations (no charter flights are allowed to land in Mauritius) seem to move in the right direction. But to remain internationally competitive in the future, attention must also be given to water quality in the lagoon, the status of the protective reefs, the preservation of original landscapes and cultural attractions.

In a way high level selective tourism in international competition turns out to be conducive to environmental protection. It provides a very quick economic feedback mechanism that cannot be ignored even in short-term politics. Already small signs of environmental destruction and pollution may cause tourists to go to cleaner island destinations instead.

### **4.4. Population and Labor Force**

The role of population variables in actual and hypothetical past developments has been discussed above. Mauritius now has passed the fertility transition and it cannot be imagined that fertility would return to high premodern levels in the future. The population presently still grows by 1 per cent per year which is entirely due to the momentum of population growth, i.e. the young age structure of the population and some mortality improvements. For the future, alternative fertility assumptions are considered separately for all three educational groups of women that result in fertility levels somewhat above replacement level ("traditional") or below replacement level ("modern"). Fertility is also influenced by changing educational compositions for the population. In the traditional case the total population size of Mauritius would increase from presently 1.1 million to 1.9 million by 2050; in the "modern" case it would only increase to 1.25 in 2020 and then decline to 1.12 by 2050.

These alternative population sizes and structures also have a sizable impact on the future trends in the economic variables of the model. When comparing the two scenarios, which both have the "boom" assumptions in the economic sector and the "garden" assumptions in the environmental sector, the "modern" assumptions in the population-education sector result in twice as much per capita income in 2050 as the one using the "traditional" assumptions. Hence stagnation in the social development that brings lower fertility and higher productivity through better education would have serious negative effects even under otherwise very favorable economic conditions.

Size and quality of the labor force are of special concern. For the past two decades the World Bank has identified the Mauritian labor force, including an increasing number of educated women, as "the engine of economic growth". If Mauritius is to be successful in expanding into new markets requiring higher technology, the quality of the labor force once again will be the key for success. For this reason the economic development plans of the government put high emphasis on further technical training of the labor force. As long as the local expertise is flexible enough to adjust to new technologies, investment into human capital will be one of the most effective and most robust strategies for sustainable economic development in Mauritius.

#### **4.5. Dependence on the Global Economy and the Global Environment**

While Mauritius is rather isolated geographically, it is heavily interwoven into the global economy. The overwhelming dependence on export earnings and imports of food and most other consumer goods has a long tradition. A change of this situation does not seem to be possible without a significant loss in welfare. Especially with a further diversification of export and import markets that makes Mauritius less vulnerable to possible crises in different world regions, the benefits of such an international orientation outweigh the risks by far. But, as indicated for the question of food self-sufficiency above, a maximum of flexibility in the change of markets and necessary imports is an important component of resilient development strategies.

In the case of the environment, Mauritius is hardly affected by any transport of pollutants from other countries, but it would certainly be affected by changes in the global climate. The Mauritian contribution to global warming is negligible not only because of its small population but because of one of the lowest CO<sub>2</sub> emissions per GNP in the world. Present general circulation models are not yet detailed enough to study the impact of a double CO<sub>2</sub> climate on rainfall and temperature, given the Mauritian topography. For the region the various models tend to show a temperature increase of 2–3 degrees Celsius and also some increase in precipitation in the already wet months. Effects of a possible increase in the sea level depends among others on the question whether the coral reefs are healthy enough to grow with the same speed. Probably the most relevant question for Mauritius is the future of cyclones, since Mauritius is situated in the usual path of cyclones through the Indian ocean. If the intensity of cyclones increased, this would be destructive; if their paths changed it might be advantageous; and if the frequency increased with lower intensity, this may also be good because of more rain.

#### **4.6. Conclusion: Towards a Prosperous Garden Island**

The scenario that combines all the "good" assumptions in the three segments of the PDE–Mauritius ("modern" for the population sector, "boom" for the economy, and "garden" for the environment) can be called the "Prosperous Garden Island Scenario". This scenario points the direction towards sustainable development. It is called "garden island" because Mauritius has little original nature left and already has a largely man-made environment. For this reason the metaphor of a man-made well-kept garden is seen as appropriate for Mauritius. It also reflects the high population density and need not be in conflict with economic growth and prosperity. In fact some wealth is

necessary to sustain the garden. It also requires wise environmental legislation, good infrastructure as well as the skills and willingness of the population to take good care of the garden. In most of these aspects Mauritius presently seems to be on the right track.

## **5. Past Policies: What Triggered the Rapid Fertility Decline?**

While most of the previous discussions were concerned with the effects of population parameters on the rest of the system, we will now focus on the determinants of these demographic parameters. In specific, we will look at fertility and again study the remarkable Mauritian experience. The total fertility rate in Mauritius declined from a level of 6.2 in 1963 to only 3.2 in 1972. This decline happened essentially parallel within all ethnic groups. This is assumed to be one of the most rapid fertility declines in the world. In this section, an attempt is made to identify the most important factors that contributed to this drastic change in reproductive patterns.

### **5.1. Social and Economic Development before the Fertility Decline**

A most remarkable feature of the Mauritian fertility decline is that it happened in the absence of any economic growth. Per capita income was very low and stagnant during the 1950s and 1960s (see also Figure 6). This contradicts the popular view that economic development is the major reason for a decline in desired family size and consequently fertility. Figure 8, however, shows that the relationship between economic growth and fertility decline is varied across developing countries. In some cases such as Mauritius, Bangladesh and to some extent Thailand, the fertility decline preceded economic growth. The historical fertility transitions of some European countries (e.g. Finland) also showed this pattern. In a number of countries fertility declined simultaneously with increasing income, and in a third group (mostly Arab countries) income grew without much fertility decline. This comparison shows that on an empirical basis, it is hard to argue that income growth is an essential determinant of declining fertility. Similar diversity of the fertility-income relationship is also shown at individual levels (such as in the World Fertility Survey, Cleland and Scott, 1987).

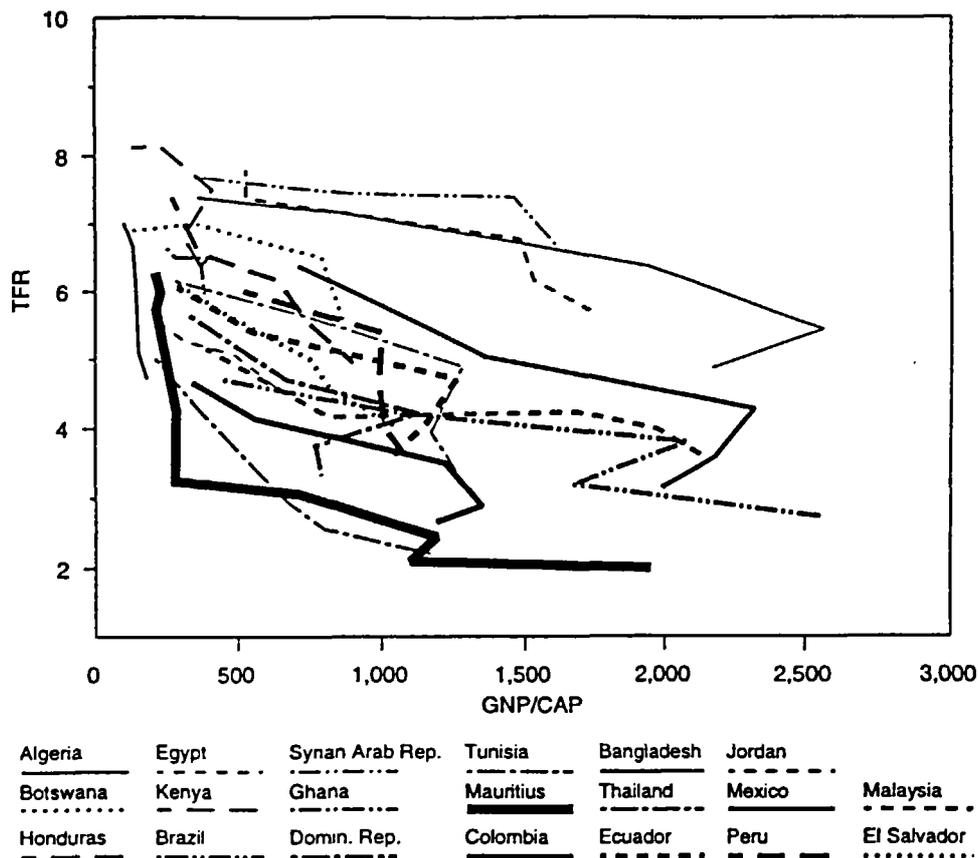


Figure 8. Relationship between per capita income and fertility in a sample of developing countries 1970–1990 and in Mauritius 1950–1990.

In Mauritius, income had not grown in the years prior to the onset of the fertility decline, but social development and especially education were well advanced by this time. Already in 1960 universal primary education had been nearly achieved in Mauritius and aspirations for secondary education for girls almost equaled that for boys. This high educational status of the younger generation and especially of younger women comes out as probably the single most important factor in explaining the Mauritian fertility decline. This assumed effect of female education on fertility can be seen as operating through three different mechanisms: first, it increases the age at marriage, and indeed it could be shown that about half of the steep fertility decline in Mauritius is attributable to changing marriage patterns; second, education is likely to change the value system by putting more emphasis on the life opportunities of children and women than on a large number of children; finally, there is evidence that education increases the acceptance of family planning methods by women and increases the relative status of a woman within the family to carry through her own (usually lower) desired family size.

In sharp contrast to the non-relationship between fertility and income in Figure 8, Figure 9 shows that the strong association between basic female education and the onset of fertility transition that is observed for Mauritius is very common in the rest of the world as well. As the sample of twenty other developing nations shows, there seems to be some kind of threshold at the point when about half of society's women can read and write. Since educational efforts are usually rather recent, this means that

in practice most younger women are literate, while illiteracy is still high among the elderly. Only in some Arab countries is this threshold not clearly visible.

The literature on the relationship between fertility and education as well as between fertility and income is extremely large. No attempt was made to review it here. It should only be pointed out that Mauritius is just one additional strong piece of evidence supporting the already overwhelming evidence (especially on the micro-level) that basic education, especially of women, is an extremely important factor in explaining the onset of fertility decline, whereas increasing income had no visible direct role in Mauritius.

## **5.2. The Role of Ethnic and Religious Factors**

In the early 1960s the scientific reports by Titmuss (Titmuss and Abel-Smith, 1968) and Meade (1961) on the future of Mauritius had both identified rapid population growth as the major obstacle to development. These scientific studies had an important influence on policy makers and also on the general public in Mauritius to understand that--to use Malthusian language--the island would have to suffer from a positive check (i.e. increased mortality) or at least severe poverty, if no preventive check (i.e. declining fertility) was found.

The influential religious communities, although traditionally pronatalist (Roman Catholic, Hindu, Muslim) found it difficult to oppose this argument, especially on a small island where spatial limitations were clearly visible. As to the Catholic church, which was most influential on Mauritius, it is largely the merit of one individual, the French Jesuit Lestapis, to convince Catholic authorities and politicians that the church doctrine was not against family planning in general but only against certain methods. As a consequence, Catholics did not block the introduction of government supported family planning programs, but established their own family planning organization which only propagated natural methods and also received government support.

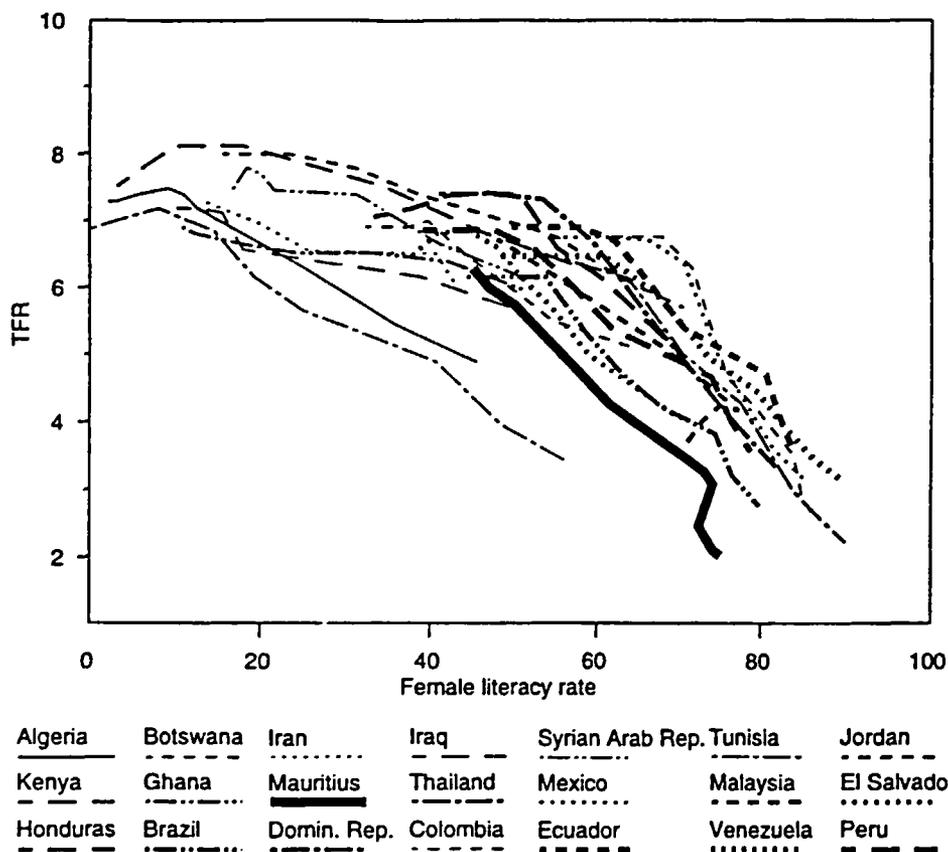


Figure 9. Relationship between female literacy rates and a sample of developing countries (1950–1990) that had a Total Fertility Rate above 6.0 in 1950.

In his report Titmuss (published as Titmuss and Abel-Smith, 1968) had expected that the great ethnic diversity of Mauritius would present a major problem to the acceptance and success of his recommendations. But this was not the case in Mauritius. Fertility declines within the Hindu, Muslim, and Chinese communities were even more rapid than in the total population that included the 'General Population' (a residual category including Europeans, Africans, etc.) in which fertility had already been below average in 1962. In Mauritius other factors were obviously strong enough to easily overcome the potential impediment of ethnic diversity. There has always been peaceful coexistence between the religions in Mauritius, and religious leaders have shown flexibility in the family planning issue.

### 5.3. The Role of Family Planning

The declines in age-specific fertility and marriage rates as well as the use of various family planning methods since 1962 have been well monitored in Mauritius (Xenos, 1991). It has been calculated that about half of the births averted between 1962 and 1972 are attributable to marriage postponement, the other half to a drop in marital fertility. This coincidence of rapid transition in marriage patterns as well as in marital fertility may explain the extraordinary speed of the Mauritian fertility decline. In 1952 57 per cent of the young Indian women aged 15–19 were married in Mauritius. By 1962 this percentage had already declined to 37 per cent, and further declined by more than

half to 15 per cent in 1972. In the age group 20–24 the percentage fell from 85 per cent in 1962 to 58 per cent in 1972. This trend towards increasing age at marriage was universal among all ethnic groups.

The decline in marital fertility was strongest at the higher age groups, a typical pattern for fertility transition. In the age group 30–34 the birth rate declined from 0.256 in 1963 to only 0.128 in 1972. For all age groups above 35 the rates more than halved over these few years. The "Index of Family Limitation" increased threefold over this period. This is directly related to the strong family planning efforts in both propagating smaller families and providing efficient contraceptive methods, together with village level health care and counseling.

Although the decision to launch strong family planning efforts was based on a broad national consensus and saw active government support, the external financial contributions of IPPF and UNFPA were also instrumental for the successful implementation on a larger scale. The number of new acceptors to the two Mauritian family planning organizations grew very rapidly during the late 1960s and peaked around 1970–72. Surveys showed that contraceptive use had reached 46 per cent in 1975 (30 per cent "supplied" and 16 per cent "natural" methods) and 74 per cent in 1985 (44 per cent "supplied" and 30 per cent "natural"). In the early 1970s the density of family planning clinics was one of the highest in the world.

#### **5.4. Conclusion**

Based on extensive surveys of historical and modern fertility transitions Ansley Coale (1974) specified three preconditions for the introduction of deliberate family limitation, i.e. fertility control dependent upon the number of children already born. All three of these conditions find strong support from the study of the Mauritian fertility transition.

1. "Fertility must be within the calculus of conscious choice." This refers to a mental and cultural transition that seems to be intimately tied to education, especially female education. Also the fact that Mauritius has a minority group of French origin with already lower fertility in 1962 may have facilitated a kind of cultural diffusion process on this issue similar to that in Europe at the beginning of this century.
2. "Reduced fertility must be advantageous." It was both on the macro and micro levels that Mauritians understood that lower fertility was advantageous to them. On the macro level the scientific reports by Titmuss and Meade seem to have been of crucial importance. On the level of families it seems to have been the rather high cost of education together with the high desirability of education as a prerequisite for a career that made some difference. Also the early introduction of social policies to support the disabled and elderly made parents less dependent on their children.
3. "Effective techniques of fertility reduction must be available." The wide distribution of modern contraceptive methods and especially the pill through family planning organizations certainly facilitated the rapidity of the fertility decline. Both international aid and good local organization were also instrumental and show that motivation to limit family size need not entirely rely on the supply

of modern methods. Without such methods, however, fertility would most likely be higher in Mauritius today.

## **6. Policy Priorities for the Future: Investment in Human Capital**

There seem to be two most important policy issues which become apparent when studying the history and the future of Mauritius under a truly holistic perspective, that may be partly generalized to other situations.

### **6.1. Farsightedness and Accountability**

In Mauritian history, things went well when the persons in charge had a longer time horizon; irreparable damage was caused when immediate advantages were the only objective. For example, the scientific studies on Mauritius in the 1960s, showing that a change was necessary, had a long time horizon and were fortunately heard by responsible politicians, and understood on individual and societal levels. Such flexibility and farsightedness was the basis for the Mauritian success story. Similar foresight is being shown now in the first steps being taken by Mauritian authorities towards sustainable development which cares for the environmental heritage.

A comparison of Mauritius to other countries in the African region since the 1960s shows that one of the major non-material differences is that during the whole period, Mauritius had a truly democratic system. Despite the extreme ethnic heterogeneity this system managed to settle conflicts peacefully and develop a sophisticated balance of power. Although this dimension is beyond our quantitative model, it comes out as number one under a holistic perspective in the historical analysis.

Many things could have gone wrong in Mauritian politics that could have inhibited development or even ruined the island. Desperate economic conditions and extremely high unemployment--in 1983 still half of the male youth cohort born around 1960 was unemployed--could have easily started ethnic tension and conflict over continuing severe social inequalities.

There are several explanations why the peaceful coexistence of very diverse ethnic groups that differ not only by language, religion and skin color but to a large extent also by social class, was possible in Mauritius while similar settings cause severe disruptions and civil war in other parts of the world. One reason may lie in the fact that no group can claim to be the original population of the island because everyone descends from immigrants. Another reason is that under the British rule, 1810-1967, the very influential and rich Franco-Mauritian estate owners were allowed to keep their land and language but not political power, and they learned to find other mechanisms to serve their interests. Finally, after independence the first prime minister, Sir Ramgoolam, established an important Mauritian tradition of ruling by consensus by inviting the conservative party to share power although his Independence Party had a sufficient majority in parliament.

Despite many political squabbles, in most issues of real importance for Mauritius, farsightedness was paired with personal accountability. Decision makers who are accountable to the majority of the population, including families and the children who

represent the future generation, and who do not primarily serve their own interests or those of a subgroup, seem to be a basic prerequisite for sustainable development.

The political accountability in Mauritius is extended to the individual level where it is understood that one is accountable for one's own choices, including the number of children, education, private business and the environment. This may be seen as a prerequisite for the demographic transition as well as for modern economic development in balance with the natural environment. This empowerment of the people themselves seems to be the major underlying reason for the Mauritian success story. The people can read, they are informed about most critical issues, and they have shown that they can take an active role in determining their country's fate.

## **6.2. Investment in Human Skills and the Status of Women**

The above brings us to the second important policy lesson, the crucial importance of the human resource in sustainable development. The story of Mauritius tells us that the first policy priority in international efforts for sustainable development should be focusing on the development of people or what economists call human capital. This is the "ultimate resource" under a longer time horizon but in terms of skills (and attitudes) rather than sheer quantity. It is not the starving and unskilled desperate people who bring about progress, but those who have the skills and the possibility to think creatively and care about others at all different levels. The Mauritian experience suggests that education is the key, especially basic education of broad segments of the population rather than of elites in an otherwise illiterate society.

More specifically, it is the basic education of women and their status in society that seems to have a very important role in the transition to lower fertility. It may also be conducive to sustainable development through increased female activity and greater weight of women in decision making together with their supposed tendency to care more about the future of their children and harmony with nature than about unnecessary consumption and technology. On this last presumption, however, little empirical analysis has been done so far. But the gender dimension at familial and societal levels certainly needs more attention in the context of sustainable development.

Provision of family planning services, one specific and heatedly-debated policy issue, is one of the factors that is conducive to the fertility transition and is desirable not only for macro-level considerations but also for facilitating individual choice and personal life course planning. Family planning, however, should not be singled out of the context of female status and health care, and pushed as an independent "engineering" solution. This does not work and can be counterproductive. Instead it should be viewed as one aspect of empowering women, men and families to more actively plan their lives and those of their society. It is part of the investment in the human resource.

With respect to the priorities in international development policies, this suggests a radical change of emphasis. Less attention should be given to large-scale technological projects that often prove to be inappropriately designed for the specific local conditions and may even turn out to be harmful to the environment and the social fabric. In contrast, investment into the human resource, into education, health and family planning can hardly be wrong, but is likely to result in immeasurable and far-

reaching benefits to individuals, communities and nations. It is a very robust policy that may only show modest immediate results, but greatly pays off in the longer run.

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## CHAPTER 8

# METHODES ET ANALYSES DE LA RELATION POPULATION-MILIEUX NATURELS DANS LES CAMPAGNES: LE PROGRAMME DYPEN EN TUNISIE<sup>1</sup>

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Dans les pays du Sud: la croissance démographique est récente et rapide, le progrès sanitaire ou technique, venu d'ailleurs, n'est pas le produit direct de l'évolution des sociétés et les effets de sa diffusion se sont exercés autant sur les modes de production agricole que sur l'évolution des sociétés. L'emprise agricole s'y est accrue dans des conditions souvent désastreuses (surexploitation des terres anciennement cultivées, mise en cultures de terres à risques, surutilisation des systèmes d'irrigation, diminution des espaces forestiers). Les paysages changent accompagnant les mutations sociales dans des évolutions où peu à peu les modèles de reproduction familiale, de comportements alimentaires et d'habitat, de transmission du savoir technique et culturel se transforment. Ces évolutions par leur rapidité, par l'intensité de leur diffusion, impliquent des conséquences sur les équilibres naturels qui sont aujourd'hui très mal connues. La formalisation intégrée de l'ensemble de ces évolutions n'est pas en effet des plus simples: comment intégrer un facteur immédiat et aggravant (la croissance de population) et ce qui relève de facteurs de fond (modèle de croissance économique, pauvreté et problèmes de survie, inégalités Nord Sud...) qui sont difficiles et longs à changer, comment les relier aux facteurs écologiques? Se posent un problème de niveau de l'observation, d'échelles et celui de la nature du questionnement ou si l'on préfère celui de l'enchaînement des questions.

Les milieux naturels ne sont, en effet, uniformes ni dans l'espace, ni dans le temps: ils ont une certaine hétérogénéité et une variabilité propre et ils ne peuvent être étudiés que par rapport au type d'organisme étudié: c'est un problème d'échelle. En effet, il y a autant de descriptions d'écosystèmes que d'échelles de cette description. Par ailleurs, c'est du fonctionnement du système social que dépendent les actions exercées sur les systèmes écologiques ainsi que de la façon dont les êtres humains perçoivent l'environnement et de la valeur qu'ils lui accordent (Galopin, *et al.*, 1989). De ces micro-décisions au niveau local dépendent nombre de changements globaux. Cette variabilité sociale peut être courte et imprévisible. Comment concilier dans l'observation cette hétérogénéité et cette variabilité? Une première difficulté surgit: les états observés sont surtout liés aux états antérieurs de l'environnement socio-culturel et économique, mais également aux états antérieurs du milieu. Le niveau connaissance de ces états sera rarement homogène. La seconde difficulté n'est pas moins importante: pour autant que son choix soit judicieux, quelles causes peut-on attribuer à la variation d'un indicateur donné. Chaque série de questions entraîne de nouvelles. C'est ce type de problèmes qui nous a été donné de percevoir dans l'expérience que nous menons dans le milieu rural de la Tunisie.

# 1. La formalisation théorique: "populations rurales et milieux naturels"

## 1.1. Les relations villes–campagnes

La campagne a fonctionné longtemps en régime autarcique: autosubsistance, production fonction de la population habitant sur le site ..., aujourd'hui elle est organisée pour produire au maximum et exporter sa production vers les villes... elle nourrit la ville, elle ne peut plus subsister seule... la technologie vient de la ville. Celle-ci ne produit rien sinon de l'information, elle transforme les produits (énergie, mines, denrées alimentaires), apporte aux campagnes les moyens de produire plus. Il y a intégration de sous-systèmes complémentaires, dissemblables, mais dépendants l'un de l'autre.

La boucle d'assistance technique qui en découle, repose sur des structures inventées par la ville et introduites dans les campagnes suivant une stratégie qui se fonde sur un développement national et, dont la répartition régionale apparaît comme un sous-produit des grands agrégats nationaux. Schématiquement cette stratégie repose sur quatre grands champs de décision:

- la politique agricole: production et commercialisation des ressources alimentaires tirées de la terre, gestion du patrimoine foncier,
- l'aménagement du territoire et les grands travaux d'infrastructure: voies de communication, barrages, irrigation, création de nouveaux périmètres agricoles..,
- les politiques de défense de l'environnement: mise en défense, reforestation, lutte contre l'érosion, l'aridité, et bientôt la préservation des ressources phyto-écologiques, de la bio-diversité etc ...
- enfin la politique démographique et de santé: maîtrise de la descendance, lutte contre la morbidité, politiques migratoires et de distribution spatiale etc ...

L'ensemble de ces interventions peuvent conduire à une réduction de la diversification des productions au niveau local avec comme conséquences une fragilité économique plus grande des économies régionales (plus grande sensibilité des productions agricoles au prix des marchés) et une fragilité écologique grandissante (monocharge sur les milieux naturels... type d'intrants chimiques ou aménagements monofonctionnels). Suivant la logique des systèmes, les campagnes contrôlées dans leur évolution démo-économique par l'extérieur sont soumises à de fortes fluctuations quantitatives, aggravées par les aléas de la production (conditions climatiques et pluviosité). Ainsi, les populations locales se trouvent subir trois types de pressions:

- démographiques (dynamique de population spécifique, mais également influence des niveaux différentiels de population avec d'autres régions, ou pressions directes par l'apport de population ..).
- économiques (produire plus ...)
- écologiques: dégradation, aléas climatiques...

## **1.2. La définition d'un "champ de référence écologique"**

Outre les changements dans la gestion et l'organisation des exploitations agricoles, les réponses des populations à ces pressions sont sociales et familiales, en particulier le recours à l'émigration et ou l'adaptation des comportements matrimoniaux. Définir un champ de référence implique donc la prise en compte de toutes ses composantes: population – organisation sociale, économique et culturelle – environnement interne et externe – technologie. Le concept de "champ de référence écologique" définit les relations entre les notions de systèmes écologiques et les notions d'anthropisation au niveau d'un ensemble campagnes (nature exploitée) et villes (milieux artificiels conçus autour des besoins sociaux). Les diverses variables de ce champ peuvent être la base explicative de relations entre les différentes composantes et leurs propriétés. Par exemple, le nombre des enfants, la taille et la composition des familles, l'existence ou non de membres de la famille en émigration... peuvent être mis en relation avec la forme de la production agricole (augmentation du cheptel, des surfaces cultivées) ou avec les changements dans les techniques d'exploitation (introduction d'intrants chimiques ou mécaniques ou de nouvelles espèces végétales), saisir enfin l'impact de la commercialisation des produits de l'exploitation etc ...(Picouet, 1993).

## **2. Les contextes de l'expérience en Tunisie**

### **2.1. Le contexte scientifique**

L'approche scientifique est pluridisciplinaire. Il ne pouvait en être autrement en raison même de la diversité du champ à observer: état de l'évolution des milieux naturels: sols, ressources en eau, couvert végétal, situation des modes d'utilisation des terres, dynamique démographique et sociale etc ... L'étude est menée par un collectif de recherches groupant trois Instituts Tunisiens: l'Institut Sylvo Pastorale de Tabarka (ISPT), l'Institut des Régions Arides de Médenine (IRA), le Commissariat Régional de Développement Agricole de Siliana (CRDA), ainsi que le Laboratoire Population Environnement (LPE) de l'Université de Provence/Orstom et de l'ORSTOM-Tunisie. Le protocole de recherches s'est ainsi établi tout d'abord sur la base d'un questionnement partagé entre toutes les disciplines sur les relations entre la croissance de population, les activités humaines, ici essentiellement agro-pastorales et l'évolution du milieu naturel, ensuite sur le choix dès le départ d'une approche en modes synchrone et diachrone (analyse longitudinale et transversale) avec l'utilisation simultanée de la photo-interprétation et de l'imagerie satellitaire, des analyses du milieu naturel (sols, végétation) et des enquêtes auprès des ménages (aspects agronomiques, démographiques et socio-économiques).

### **2.2. Le contexte démographique**

Le taux d'accroissement de la population du pays est actuellement de 2,5 pour cent par an, il demeure plus rapide dans les campagnes de l'ordre de 2,7 à 3 pour cent . Dans les trois zones choisies le taux d'accroissement est cependant plus faible de

l'ordre de 1,6 à 1,8 pour cent, en raison principalement de la ponction opérée par les phénomènes migratoires internes et externes et de l'élévation de l'âge au mariage. L'indice synthétique de fécondité est de 4,72 enfants par femme en 1984 pour la Tunisie et de 3,34 en 1991, soit une baisse conséquente qui reste cependant très diverse suivant les régions. Dans la zone Nord il est passé au cours de la même période de 5,3 à 2,8 enfants par femme, dans le Centre de 4,8 à 3,3 et dans le Sud il se maintient en 1989 à 4,1 enfants par femme. Dans l'ensemble la parité des femmes en fin de procréation reste plus élevée que la moyenne nationale, autour de 7,3 pour le Sud contre 6,5 pour le pays et 6,9 pour les campagnes. La baisse de la fécondité est ainsi générale, mais elle semble aujourd'hui marquer le pas. Néanmoins on peut constater dans certaines régions rurales une tendance au retard à l'âge au mariage notamment pour les femmes: une tendance qui s'est peu à peu affirmée depuis les années 1970: de 26,4 ans pour les hommes et 16,6 pour les femmes en 1966, cet âge était de 27,7 ans pour les hommes et 24,2 pour les femmes en 1984.

### **2.3. Caractéristiques des campagnes (d'après Floret, Khattali, Le Floch, Pontanier, 1989)**

- Les aléas de la pluviosité sont loin d'être complètement maîtrisés. Pour lutter contre l'aridité et améliorer les potentialités agricoles l'arido-culture, l'élevage, l'irrigation ont été développées... ces pratiques liées directement avec la dynamique de population, ont induit dans la majorité de ces interventions un risque de dégradation et de désertisation. L'augmentation de la population et de sa sédentarisation dans les villages offrant écoles, dispensaires etc. ...qui se fixent sur les piémonts des montagnes pour bénéficier du ruissellement et à proximité des zones inondables pour la pratique des cultures vivrières de décrue... a profondément transformé les paysages, en particulier dans les zones les plus arides. Ces changements dans le mode d'habitat se sont accompagnés de modifications dans les systèmes fonciers et l'utilisation qualitative et quantitative des ressources naturelles avec une emprise agricole accrue.
- Les modifications des systèmes écologiques: défrichement des steppes et croissance de l'érosion hydrique sur les piémonts, céréaliculture des steppes de zone sableuse réduisant les zones traditionnelles de paturages... se sont traduites par le lessivage des sols plus intensif et la diminution de la capacité d'absorption des eaux de pluie, aggravant le risque d'inondations localisées. La pression des animaux domestiques s'accroît sur les steppes à sols superficiels qui sont peu aptes à la mise en culture. Il y a une diminution des steppes pastorales en bon état et de plus en plus atteintes de seuils au delà desquels les possibilités de reconstitution du couvert végétal sont très faibles.
- Dans bien des cas, le prélèvement dépasse la capacité de renouvellement et les processus de désertisation sont engagés, le retour d'années plus favorables en pluviosité, ne permet toujours pas la remontée biologique du milieu naturel, (irréversibilité des processus de dégradation). Ainsi, face au faible dynamisme biologique du milieu (vitesse de cicatrisation de la végétation, importance des phénomènes de régénération), la baisse de productivité biologique peut être irréversible pendant plusieurs générations, même avec des mesures de protection et de mise en défense. Les interventions pour lutter contre ces

évolutions ont été nombreuses, pas forcément avec le même succès mais suffisamment efficaces dans certaines régions pour voir se ralentir les processus de dégradation, assister même à des remontées biologiques significatives. Ces interventions ont porté sur une utilisation des conditions favorables du milieu par:

- l'adaptabilité des espèces à la variabilité temporelle des précipitations,
- le maintien de la diversité des races biologiques,
- l'utilisation de la plasticité des races locales d'animaux domestiques (les ovins de race barbarine peuvent supporter des pertes de poids considérables),
- la plantation des arbustes fourragers,
- l'intégration des zones irriguées et les parcours,
- la récupération des eaux de ruissellement par des petits barrages successifs (jessours, tabias) et des lacs collinaires, les techniques traditionnelles de concentration des eaux sont en général efficaces,
- Le problème majeur est l'offre décroissante de main d'oeuvre agricole. Paradoxalement en période de croissance démographique celle-ci se raréfie et l'entretien des terres devient aléatoire: manque d'hommes, perte de l'expérience acquise au fil du temps, en raison de l'éducation qui éloigne la population active des métiers manuels et de la recherche d'un revenu monétaire... qui accentuent les tendances à l'émigration. En situation de pression démographique et des besoins accrus des populations (en particulier urbaines), se fait jour une tendance à l'intensification agricole. Autrement dit, l'étendue des terres cultivables et l'état des techniques étant donnés, les agriculteurs se résignent à recourir, de période ne période, à une quantité accrue d'intrants (engrais, mécanisation) par unité de production pour augmenter les rendements et pallier dans une certaine mesure la baisse de la main d'oeuvre agricole.

### **3. La problématique générale**

#### **3.1. Les objectifs**

Dans ce contexte, les questions portaient au départ sur l'effet possible de la migration, elle même soutenue par une pression démographique forte, sur la dégradation rapide observée des milieux naturels et l'avenir de ces populations rurales. Questions qui se sont résumées dans les objectifs suivants:

- décrire les états de dégradation des milieux naturels et en identifier les causes immédiates. En parallèle, analyser le dynamisme démographique et social en fonction de l'occupation des terres et de leur utilisation, avec comme objectif des propositions d'action de mise en valeur et de développement régional,
- étudier les processus d'adaptation des populations à leur environnement, en particulier saisir l'impact des déplacements sur le milieu naturel et apprécier l'influence des évolutions historiques sur les systèmes de production agro-pastoraux, en insistant sur le degré d'artificialisation des milieux,

- avancer des propositions pour de nouveaux équilibres environnement–population dans le cadre d'un schéma prospectif à moyen terme allant dans le sens de la reconstruction des milieux dégradés.

Qui se structurent en trois types d'analyses:

- la première axée sur l'évaluation des problèmes environnementaux face à la croissance actuelle de la population, il s'agit ici de faire un état de la situation, d'identifier les facteurs déterminants de déséquilibres et de ruptures et d'isoler les contraintes propres aux écosystèmes de chaque zone,
- la seconde a trait à l'étude des relations entre les évolutions passées et les potentiels de croissance actuels dans une approche diachronique des phénomènes écologiques,
- la troisième, prospective, devrait permettre de différencier les tendances non maitrisables des évolutions futures de celles qui peuvent l'être, et de construire des modèles d'évolution prévisibles sur la relation population–milieux naturels.

Comment concilier dans toutes ces approches les observations écologiques et les analyses socio–démographiques de l'évolution des populations?

### 3.2. Une démarche comparative pour le choix des zones

Un premier constat: la charge humaine est fonction du bio–climat, à 50 mm de pluie la charge est en effet beaucoup plus nocive et beaucoup plus difficile à gérer qu'à 1000 mm de pluie. La capacité de comparaison de l'étude dépend donc étroitement des critères de choix des zones d'étude. Cela imposait de retenir des zones:

- à gradient bio–climatique et d'aridité différente,
- de conditions de peuplements spécifiques (mode d'occupation et d'utilisation des terres),
- correspondant à une ou plusieurs unités administratives, (Imadat)

Ces critères ont conduit à choisir trois régions rurales de la Tunisie continental. A l'intérieur de celles-ci, les zones d'études retenues tiennent compte d'échelles d'analyses différentes, qui permettent d'intégrer des ensembles de micro–zones représentant un tapis végétal homogène pour les milieux naturels et une ou plusieurs unités administratives pour les enquêtes sur la population. En raison des modes d'occupation et de l'utilisation du milieu naturel par l'homme, d'une dynamique démographique vivace, les trois régions sont particulièrement touchées par les phénomènes de dégradation des sols et de la végétation:

- la région du Nord–Ouest comprend principalement la Kroumirie et les Mogods couverte ici en grande partie par une forêt de chêne liège, de type mésophile, à la pluviométrie abondante et dont le dynamisme du tapis végétal est intimement lié à l'activité humaine (paturages en forêt, défriches pour cultures, arrachage pour charbon de bois, vieillissement de la forêt). C'est une région à forte densité de population connaissant une émigration forte, mais récente, liée autant à la forte croissance démographique de ces dernières décennies qu'à la destructuration des activités agricoles traditionnelles. Le poids démographique y est encore important en rupture avec les potentialités économiques de la région. Deux zones retenues: Ain Snoussi et Ain Sobah,

- la région de Silliana avec ses contreforts steppiques lessivés par l'érosion, terres traditionnelles de cultures et de transhumance, objet d'interventions planifiées constantes, subit une accélération de la pression démographique. La croissance des activités pastorales pèse davantage sur un processus de dégradation déjà fort avancé sur les piémonts relativement peuplés face à des secteurs agricoles très aménagées (cultures intensives, grandes exploitations) très peu densifiés. La migration, de développement relativement récent, apparaît comme un palliatif insuffisant à l'accroissement des déséquilibres entre les terres pauvres sur-densifiées, les espaces naturels sur-utilisés et les terres aménagées. Zone retenue: Ouled Frej,
- la région du Nefzaoua (oasis) qui se caractérise par une pluviométrie faible et irrégulière (moins de 100 ml.), un tapis végétal rare et fortement dégradé, et récemment par des activités oasiennes en extension. Le peuplement de type nomade ou sédentaire suivant les ethnies dominantes (Grib et Sabria) y a toujours été relativement intense eu égard à la fragilité du milieu naturel. Dans ces terres de refuge, les populations se sont structurées autour d'une forte cohésion sociale et familiale. Elles connaissent aujourd'hui une croissance élevée, et sont le siège de mouvements d'émigration et d'immigration. Ces derniers sont particulièrement intenses en raison de la sédentarisation des nomades dans les oasis et de l'attraction qu'exercent les nouveaux périmètres irrigués sur les populations avoisinantes. Zone retenue: Oasis d'El Faouar.

### 3.3. Le choix des indicateurs

Pour établir une relation précise entre milieux naturels et population il était nécessaire de rechercher l'interface entre les indicateurs propres à l'évolution des milieux naturels et ceux spécifiques à la dynamique démographique et sociale. Cela impliquait au niveau de chaque région:

- de rechercher les indicateurs exprimant les niveaux de sensibilité propres aux niveaux naturels,
- de rechercher les indicateurs exprimant les niveaux de sensibilités propres aux sociétés (reproduction familiale et sociale, modes de vie et de production agricole etc...),
- d'identifier les binômes possibles entre ces deux premiers types d'indicateurs (indicateurs relationnels) exprimant (ou expliquant) les écarts autour de la sensibilité potentielle, déterminés (ou provoqués) par les perturbations anthropiques.

Ensuite il s'agissait de construire à partir des indicateurs retenus des typologies significatives d'un ou plusieurs états démo-écologiques qui puissent servir de filtres discriminants à l'analyse des variables socio-démographiques. A l'issue des enquêtes sur le terrain, deux groupes de typologies se sont avérées pertinentes et synthétiques de ces états:

- un premier qui se réfère à plusieurs découpages du territoire en secteurs démo-écologiques qui définissent par exemple une partition du territoire en zones selon leur nature géo-morphologique (plaines, glacis, piémonts, montagnes...), (et) ou une partition couvert végétal-pratiques agricoles, tous ces découpages

recouvrant d'une manière précise l'implantation du peuplement (localisation physique des ménages et des exploitations agricoles) etc ...

- un second ayant trait aux typologies milieu-exploitation agricole qui résument le paradigme: "ménages, activités agricoles, milieu", la construction de ces typologies pouvant être différente suivant les zones.

#### **4. La collecte des données**

Dans la chaîne interactive homme nature, l'approche méthodologique se heurte au choix du maillon de départ par lequel les suivants sont appréhendés. Ici, l' "entrée" a été le ménage, envisagé à la fois comme unité familiale (reproduction sociale et familiale) et comme représentation des activités humaines (exploitation agricole). Les enquêtes sur le terrain ont donc porté à la fois sur les ménages et sur les gradients bio-climatiques d'implantation. C'est à ce niveau que les indicateurs relationnels (ou indicateurs démo-écologiques) ont été utilisés.

##### **4.1. Les techniques d'adéquation des différentes sources.**

La relation entre les observations passées, actuelles et les évolutions à venir, ou si l'on fait référence aux concepts utilisés en démographie la relation entre le longitudinal, le transversal et la prospective s'effectue de la manière suivante: trois types d'observation ont été utilisés:

- A. Les modes d'observation diachrones et synchrones: phyto-écologie, pédologie sur la base des observations sur des stations centrées sur les zones choisies et l'analyse de chronoséquences de photos aériennes: partage de l'espace des groupements végétaux, nature et usure des sols,
- B. Photo-interprétation et télédétection: évolution de l'occupation des sols et des indices de dégradation, systèmes de communication et de desserte des exploitations agricoles, implantation des douars et de l'habitat dispersé,
- C. L'enquête socio-démographique et agricole: échantillon de ménages-exploitations agricoles: dynamique démographique, migration, mode de vie du ménage, modes d'exploitation du milieu.

La relation entre ces divers instruments s'établit sur la base des indicateurs construits à partir des différentes sources. (A) a pour objet d'opérer une segmentation des milieux approchés suivant l'intensité et la nature des dégradations ou des remontées biologiques observées. Ce sont principalement les secteurs démo-écologiques auxquels viendront s'ajouter d'autres maillages plus directement associés à un facteur écologique (par exemple un maillage couvert végétal établi à partir des transects). Les zonages opérés sont spatialisés par (B), complétés par l'information sur l'évolution des implantations et des aménagements tirée de la chronologie des couvertures aériennes. Ces divers zonages sont caractérisés suivant une ou plusieurs typologies, qui sont autant de caractéristiques des exploitations agricoles. La démarche est de construire d'abord une typologie "ménage-exploitation agricole et milieu" que nous avons désigné TME, de la tester avant d'introduire d'autres indicateurs complexes. Cette typologie

TME est ensuite mise en relation avec les observations réalisées en (C), c'est à dire avec chaque unité "ménage, exploitation agricole".

#### **4.2. L'enquête sur les ménages et les exploitations agricoles**

Elle comportait quatre volets:

- le premier, essentiellement démographique permettant d'apprécier le niveau de croissance ou de décroissance, tant des facteurs naturels que celui de la migration considérée comme facteur de modulation ou de régulation de la dynamique démographique. Le questionnaire est constitué d'une fiche collective simple recensant l'ensemble des personnes composant l'unité d'enquête,
- le second, sur les formes d'utilisation des milieux naturels vus sous l'angle consommation des ménages: énergie, eau, habitat, équipement..,
- le troisième, sur les activités agricoles et pastorales: nature et type des exploitations agricoles, formes de production, systèmes et techniques d'exploitation, cultures, élevage, intrants agricoles, activités de cueillette... commercialisation...,
- un quatrième volet enfin sur la perception des évolutions adressé aux exploitants agricoles portant: sur les capacités productives appréciées des parcelles cultivées ou des parcours, notion des changements notamment par rapport à ce qui se faisait autrefois son père, ou ancien exploitant), appréciation de l'évolution des risques et incertitudes liées aux conditions du milieu, connaissance des seuils de ruptures des ressources naturelles à travers les indicateurs (ressources en eau: niveau des puits, ruissellement, disparition ou apparition d'espèces végétales), perception individuelle de la dégradation ou de phénomènes de remontée biologique ....

Dans chacune des quatre zones retenues, l'enquête a été menée auprès d'un échantillon de 200 ménages qui représente environ le quart de la population totale de la zone. Tous les thèmes sont présentés de manière à intégrer l'ensemble des indicateurs de dégradation (antécédents historiques, état, évolution, prémices de ruptures, de déséquilibres ou de remontée biologique...). Les résultats des enquêtes de type phyto-écologiques (s'appuyant sur des enquêtes antérieures) constituent le cadre essentiel de la préparation de ce type d'enquête. Finalement toute cette information est synthétisée dans la saisie, qui est globale et centrée sur l'unité famille-exploitation agricole.

#### **4.3. Le traitement des données**

Les secteurs démo-écologiques (typologie NS) ont été établis à partir de l'observation de l'état de dégradation des sols et de leur nature et de l'évolution du couvert végétal observée par photointerprétation. Les ménages et leur exploitation agricole sont ainsi repérés suivant le site écologique qu'ils occupent. Ce repérage ne couvre pas, loin s'en faut, tous les facteurs d'évolution des milieux naturels et il n'y a pas forcément une adéquation parfaite entre les surfaces utilisées dans l'exploitation et un secteur, en particulier lorsque l'exploitation comporte un nombre important de parcelles disséminées sur l'ensemble de la zone, par ailleurs les parcours des troupeaux

dépassent quelquefois largement le périmètre étudié. La typologie TME (Ménages Exploitation Agricole, Environnement) permet à partir de critères discriminants de surmonter cette difficulté, pas totalement, mais en grande partie.

En effet la typologie TME se construit à partir d'un certain nombre de variables observées dans l'enquête, elle caractérise le ménage à partir de ses relations avec le milieu naturel et de l'utilisation des ressources naturelles: systèmes de culture, espaces cultivés et espaces sylvo-pastoral, structure foncière et patrimoniale, types de cultures et d'élevage, énergie domestique employée... La TME ainsi constituée permet de mettre en évidence les différents systèmes d'exploitation de la nature selon les caractéristiques de celle-ci. Deux méthodes ont été employées pour identifier les variables entrant dans la composition de la TME: une méthode statistique basée sur l'analyse des correspondances<sup>2</sup> qui permet d'isoler les variables discriminantes et une méthode plus empirique par choix raisonnée effectué directement par visualisation des listes de ménages classées suivant les modalités de variables retenues. Une confrontation des deux méthodes est ensuite opérée pour fixer la TME choisie pour la zone. Le nombre de variables, leur nature entrant dans la composition de la TME sont bien entendues différentes selon les zones. Ainsi pour la zone de Ouled Frej<sup>3</sup>, 22 variables sont retenues:

#### Structure foncière de l'exploitation:

- Superficie totale de l'exploitation agricole
- Nombre totale de parcelles (Morcellement de l'exploitation agricole)
- Modes de faire valoir

#### Assolements et occupation du sol:

- Nombre d'hactares cultivés
- Diversification de la production agricole
- Superficie irriguée
- Nombre d'arbres fruitiers
- Superficie de cultures fourragères

#### Techniques culturales:

- Moyens de traction
- Amébergement de protection des parcelles
- Sens du labour
- Intrants chimiques ou organiques

#### Alimentation du Cheptel:

- Source d'approvisionnement des aliments pour le bétail
- Location de paturages
- Durée d'utilisation des jachères et des chaumes

#### Types d'élevage:

- Effectif actuel d'ovins

- Effectif actuel de caprins
- Effectif actuel de bovins

Utilisation de la montagne:

- Utilisation des parcours en forêt et garrigue
- Récolte de plantes sauvages pour la consommation
- Pratique de la chasse
- Source d'approvisionnement en bois

Muni de cette typologie on peut procéder aux croisement avec les autres variables soit de type écologique: secteurs démo-écologiques, facteurs environnementaux, soit de type socio-démographique avec des variables simples ou composées issues de l'enquête démographique et socio-économique. La confrontation de ces divers croisements permet en définitive de relier les caractéristiques environnementales aux comportements et aux stratégies des ménages et en particulier de relier les mécanismes migratoires mis en place par les populations aux systèmes d'exploitation du milieu naturel et à son évolution.

## 5. En conclusion ...

Les enquêtes de terrain sont terminées, elles sont dans leur phase de traitement. Un premier tri à plat des variables croisées avec le secteur démo-écologique a été effectué. Ce tri à plat a guidé l'élaboration et le choix des variables entrant dans la composition de la TME. L'étude des évolutions par photo-interprétation a été réalisée sur les couvertures aériennes 1954, 1962 et 1989, de même l'évolution du contexte démographique, enfin les relevés phyto-écologiques et érosion des sols...sont pour l'essentiel disponibles. Cette phase du programme se révèle délicate, chaque zone a ses spécificités, ses contraintes d'observation qui risquent de mettre en cause la capacité de comparaison recherchée. Néanmoins la quantité d'information recueillie permet déjà de relier un certain nombre de caractéristiques environnementales aux système d'exploitation des ressources naturelles et par la même de comprendre les stratégies familiales et économiques des ménages. Si la taille de ces ménages reste, par rapport à l'ensemble du pays, relativement forte autour de 6 à 7 personnes et cela quelque soit la zone, on peut constater que le milieu, les conditions de peuplement ont façonné des systèmes d'exploitation des ressources naturelles très différents suivant les régions. La taille des exploitations varie de 15 hectares dans la zone semi-aride, 1,6 en zone oasisienne et à 4 en zone forestière. Le morcellement des exploitations est également très variable. Une faible assise foncière de l'exploitation, un moindre recours à l'émigration entraînent une surexploitation des ressources forestières et des activités clandestines de carbonisation: système qui se concentre dans des secteurs déjà fortement érodées, mais qui s'est développé précisément là où il était pour les populations le seul moyen de subsister...Le programme DYPEN-TUNISIE, conçu comme une démarche expérimentale, n'apporte pas de résultats assimilables à l'ensemble du milieu naturel tunisien, il caractérise certaines relations homme-milieu dans des conditions spécifiques arides, semi-arides ou forestières en même temps qu'il propose un protocole de recherches susceptible de fournir les éléments de

compréhension des interrelations entre les dynamiques de population et les évolutions des milieux naturels. L'analyse des résultats, en cours, devrait infirmer ou confirmer cet optimisme<sup>4</sup>

## Footnotes

<sup>1</sup>Ce texte s'appuie sur la réflexion développée dans le cadre du programme DYPEN-TUNISIE, mené par un collectif de recherches groupant cinq institutions de recherches tunisiennes et françaises: Institut Sylvo-Pastoral de Tabarka, Institut des Régions Arides, Commissariat au Développement Agricole de Silihana, Ecole Supérieure d'Agriculture de Mograne, ORSTOM-Tunis, Laboratoire Population Environnement Université de Provence/Orstom. Il reprend de larges extraits de documents antérieurs: voir notamment "Dynamique de population et milieux naturels: de la formalisation à l'expérience de terrain: le cas de la Tunisie rurale" Séminaire du CEPED, 1993 et "Pression démographique et l'environnement" Article ECODECISION 10, 1993.

<sup>2</sup>Cette méthode est développée par l'unité de traitement de l'IRA (Institut des régions Arides par N. Bachar (ingénieur statisticien) et M. Sghaier (Agro-économiste).

<sup>3</sup>La TME pour Ouled Frej a été établie par L. AUCLAIR, ingénieur agronome, économiste de l'ORSTOM.

<sup>4</sup>Un premier fascicule de résultats issu du tri à plat sera disponible début 1994, la présentation des analyses au printemps 1994.

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**PART II**

**POLLS, PERCEPTIONS AND POLICIES**



## CHAPTER 9

# POPULATION AND THE ENVIRONMENT: POLLS, POLICIES, AND PUBLIC OPINION\*

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### 1. Introduction

Social scientists frequently employ sample surveys to assess public attitudes toward current or prospective government policies. Population and environmental problems are two areas of public concern and debate that have traditionally had different constituencies and leadership. However, there have been numerous recent attempts to join forces, both at the organizational and conceptual levels. As the issues evolve, there is a growing need for new social scientific knowledge, especially the assessment of public opinion toward current or potential policies on population and the environment. In this paper I will deal with several questions relevant to this need:

1. Has the demand for better policies on population and the environment produced an increase in the social science knowledge base on these subjects?
2. What data are available and what data are needed to assess the attitudes of governments toward population and environmental problems?
3. What data are available and needed to assess public attitudes on population and environmental problems?

In answering the first question I will look at trends in the number of scholarly publications over the past few decades. In answering the latter two questions, I will look more closely into the substance of past data collection efforts that concentrate on the population issue, but, where possible, provide comparative information on the environment as well.

### 2. The Scientific Knowledge Base

*Sociofile*<sup>1</sup> is a data bank of abstracts of articles that deal broadly with sociological topics. Covering roughly 1,600 sociological and related journals, it abstracted 177,728 documents between 1974 and 1992. "Demography and Human Biology" and "Environmental Interactions" are two of the 21 major subjects covered by the data base. I conducted a search that first asked for the number of citations in which the words "population," "environment," or "population and environment" appeared anywhere in the title or abstract ("Basic Index"). A second search asked for the number

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\* The research assistance of Ms. Huong Hoai Tran is gratefully acknowledged.

of abstracts in which these topics constituted the main topic of the article ("Descriptors").

As judged by the volume of abstracts, social science attention to the environment has grown markedly in the last decade. While *Sociofile's* total file grew by only 39 per cent between 1983 and 1991, the number of "Basic Index" citations on the environment increased by 139 per cent; and "Descriptors" on the environment increased almost seven fold (Fig. 1).

However, the growth in population citations, while faster than growth in overall citations, has been much slower than for environment—only 43 per cent in Basic Index citations, and 120 per cent in Descriptors. By 1991 the unequal growth rates resulted in a confluence of absolute numbers of Basic Index citations: 1061 for population and 1036 for the environment. However, environment received almost three times as many Descriptor citations (325 to 119). References to population and the environment (jointly) are few. Although Basic Index items total 1220 and have tripled since 1983, there were only 42 articles over the entire 18 year period in which population and environment was the major topic (not shown in Fig. 1).

A second source of information on scholarly productivity is *Popline*, a computerized bibliography of documents on population. Over the same period (1974–92) it has abstracted about the same number of population documents (164,349) as *Sociofile* has abstracted for sociology/social science in general. As seen in Figure 2, the total number of population citations since 1980 has been declining, whether measured by the size of the overall file (-48 per cent), by the number of documents identified as population in a "Global" search (-38 per cent), or in a "Keyword Major" search (-41 per cent).<sup>2</sup>

Over the same period, articles whose main topic is the environment (Keyword Major) have steadily increased, and Global Environmental Abstracts have shown only a slight (7 per cent) decline. Global references to population and environment have remained steady since 1981 at between five and six hundred per year but very few articles have this as their main topic: 9 in 1980, 78 in 1991 (not shown in Fig. 2).

To sum up what we have found from the abstracts in *Sociofile* and *Popline*: (1) over the past decade social science productivity on the environment has increased much faster than productivity on population, which may be in decline relatively and absolutely; and (2) productivity on the joint topic of population and environment has at best increased modestly from a very small base.

### 3. Population Policies and Government Attitudes

Population policies are not new, having been propounded by governments in classical Greece and Rome, and articulated by early philosophers from China to the Middle East. What is new is the technology available to governments (primarily modern contraception and the mass media), and the internationalization of technical assistance on population policies and programs. Newest of all is the goal of slowing population growth rates rather than sustaining or speeding them up, and, at least in a substantial number of cases, the high priority governments have assigned to population planning.

Number of Citations (Log scale)

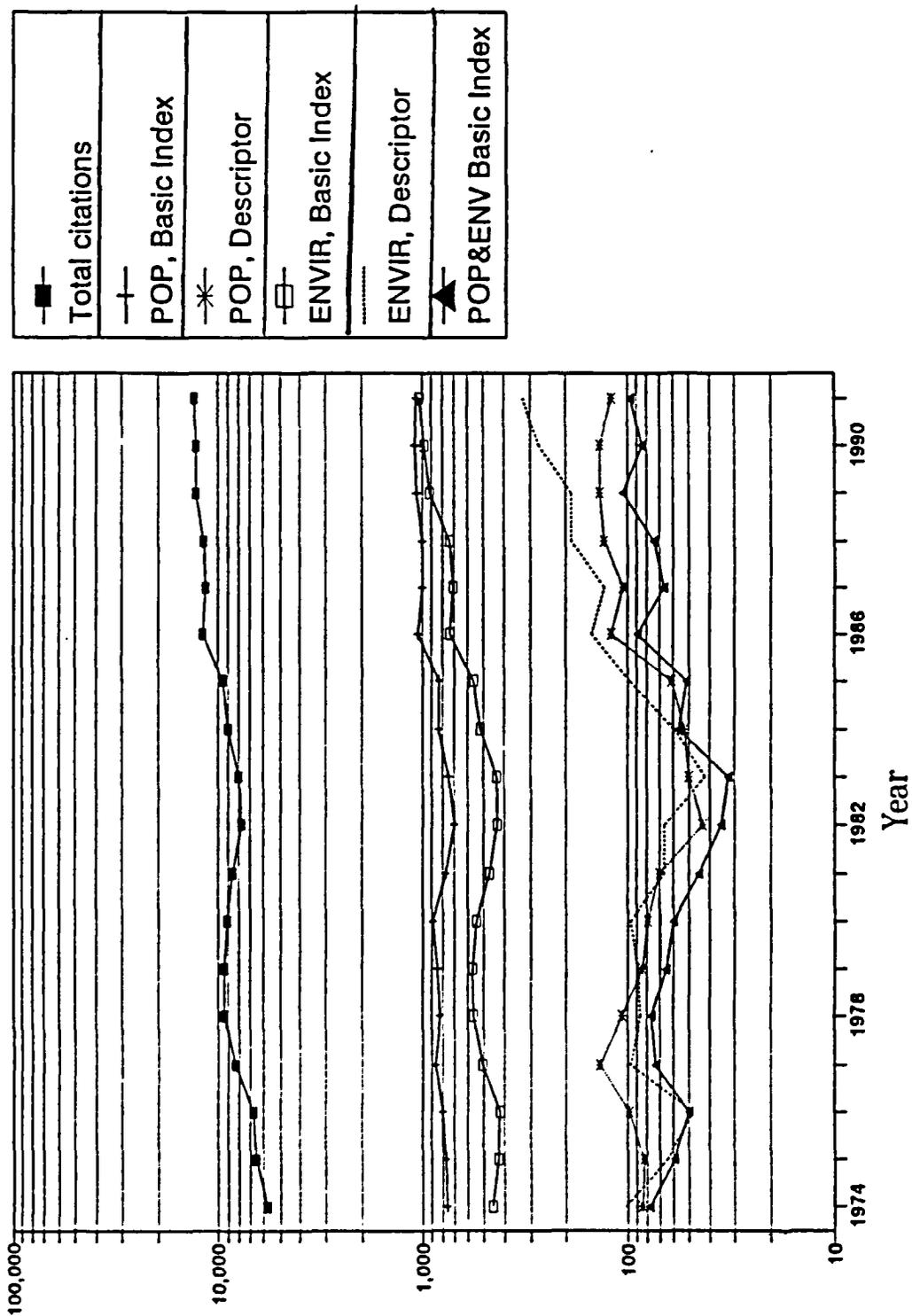


Fig. 1. "Sociofile" citations: population, environment and totals (1974-91), compiled from *Sociofile* (Silverplatter), April 1993.

Judged by these more recent criteria, population policies have existed for only a few decades. Writing in the late 1960s, Hope Eldridge (1968: 387) concluded that "Only three countries can be said to have coherent, carefully constructed and frankly stated population policies: France...Sweden...and India." The first two were more developed countries desirous of *increasing* their birth rates. Moreover, in much of the modern period, migration has been viewed as "the only major demographic process over which policy was consciously debated and fixed" (Robinson, 1975). With the development of new contraceptive methods in the 1960s and, at the urging of a few European and Asian nations, the international agencies became major instigators of population planning for the Less Developed Countries (LDCs), with family planning as the major tool.

At the end of the 1950s only six developing nations, including Tonga and Hong Kong, had policies supportive of family planning. By the end of the 1960s 45 countries had formulated policies, and by 1975 81 had done so. However, of the latter number, Watson (1977: 2) argued that only 54 could be characterized as giving "real programmatic support." Moreover, in the more industrialized nations at that time, "population ...does not rank high on the agenda of national problems. It is more given than problematic, more to be adjusted to than changed" (Berelson, 1974: 786).

A more recent review remains pessimistic concerning governments' commitments to population planning<sup>3</sup> and the ability or interest in integrating it with social and economic planning in general:

"Population factors continue to be treated essentially as exogenous planning components. The state of the art seems restricted mostly to an examination of population projections in relation to the demand for social services. In some countries even that relatively simple approach seems to have run into serious problems of application because sectoral programming and target-setting have suffered from inaccurate demographic estimates and analyses. Selection of social and economic policies and programmes, including the countries well advanced in the application of development planning, appears to be largely devoid of the consideration of their implications for demographic variables and processes" (Farooq and Pernia, 1988: 11).

Aside from such subjective appraisals, how can government attitudes on population and environment issues be assessed? I will discuss three approaches: systematic expert assessments, direct queries of government officials, and content analysis of government documents.

### **3.1. Systematic Expert Assessments**

The emphasis here is on "systematic." The prototype is the scheme developed by Lapham and Mauldin (1985: 132) wherein "some 400 population specialists around the world provided information on 30 items related to family planning programs..." The subjects of the questionnaire were judged to be experts on a particular country or countries. Their responses on policy and three other program effort categories (service, record keeping, and availability/accessibility) were given scores by the authors. The scores for policies in 73 countries ranged from 0 (e.g., Saudi Arabia and Laos) to 31 (China) and were based on the authors' evaluations of eight questionnaire items

including budget, public statements by leaders, import laws regarding contraception, and mass media attention to contraception.

This technique is a great improvement over judgments made by individual experts, since it employs many judges, breaks "policy" down into eight more objective components, and asks all judges the same questions about these components. However, it is still tainted by judgmental and subjective problems, perhaps compounded by the additional layer of authors' judgments.<sup>4</sup>

Number of Citations (Log scale)

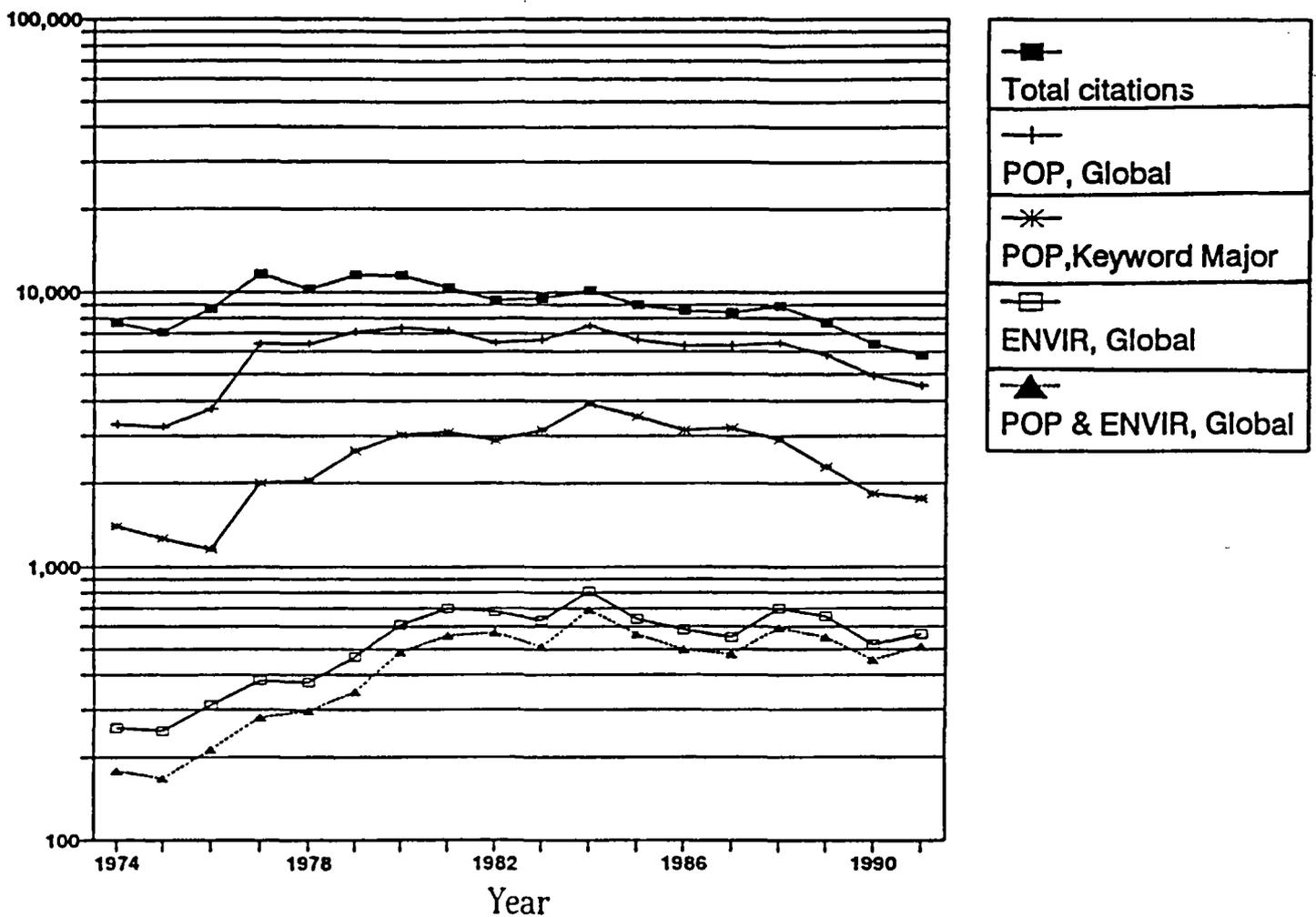


Fig. 2. "Popline" citations: population, environment and totals (1974-91), compiled from *Popline* (Silverplatter) April 1993.

The various measures are heavily weighted in the direction of family planning policies and programs, and ignore policy issues such as internal and external migration, population distribution, urbanization, etc. However, the general method could easily be adapted to a more general definition of population policy.

### 3.2. Direct Queries

The leading example of the direct query approach is the series of surveys on "Government Perceptions and Policies on Demographic Trends and Levels in Relation to Development" carried out by the United Nations (UN). Roughly every two years a questionnaire has been sent to each member nation, which is asked for its official position on population issues. A major finding concerns the growing number of nations that have formally recognized a national population problem. When the UN made its 1974 inquiry of government population policies, it found that only 28 per cent of the 156 responding nations judged their population growth to be too high, compared with 40 per cent in 1990. Further, the proportion who said they support direct access to contraceptive methods increased from 55 per cent to 76 per cent (UN, 1992:38).

Can we trust the responses of nations that claim their population growth is too high? Are they not like individuals who, when polled, may do their best to give answers that will please the interviewer? After all, as sponsor of the questionnaire, the UN could be suspected of rewarding countries that have "appropriate" policies and programs. Further, unlike a poll of persons, we really do not know how many individuals or departments were involved in answering the questions. In a large country with many departments, responsibility for responses to specific questions may be spread out over a number of persons, whereas in a small country or one with more centralized authority, an individual or a single department may respond.

Another problem refers to missing information--countries that fail to respond to the questionnaire. At the time of an initial inquiry in the early 1960s, only 44 per cent of 124 countries polled responded to the questionnaire; and, as in surveys of individuals, those who responded were different from those who did not. An analysis of this survey found that "the nonrespondents were principally the small underdeveloped countries, not the ones which traditionally oppose birth control programs..." (Back and Winsborough, 1968-69:644). Subsequent inquiries elicited somewhat higher return rates, but with considerable fluctuation, for example 47 per cent in 1978 and 72 per cent in 1982 (UN, 1989:387). This translates to an average of 63 countries that failed to answer each of the six more recent inquiries (UN, 1989:387). Certainly a non-response from a nation is more significant than a non-response from an individual. Further, why is it that Brazil has answered only one of the six inquiries, while Colombia has answered all of them? Why have Bolivia and Haiti answered three, and the Dominican Republic five?

The length of the questionnaire would certainly stun the average respondent--the 1988 inquiry was 42 pages long and contained 282 questions, 48 of them open-ended (UN, 1990). There were 77 questions on fertility and the family; 25 "how-concerned-are-you" questions regarding causes of death ranging from suicide to measles; 25 items on integrating demographic factors into development planning; and sections on

population and the status of women, and on population and peace. *But there is not a single question on the environment.*

Despite such limitations there are things we can learn from these surveys. For example, rapidly growing countries that regard their rates as satisfactory or too low may be less subject to a "courtesy bias" since their views are contrary to the current international norm favoring low rates of population growth for LDCs. Also, there should be special interest in the attitudes of industrial countries. In 1990, not one of 38 industrial countries considered its growth as too rapid, and as many as seven of them considered it to be too low (UN, 1992:48). In the light of the fact that any population growth in these countries places a heavy tax on the environment, their demographic viewpoints are of special concern. How is it that strongly Catholic countries such as Belgium and Italy with slightly negative growth rates consider their rates as satisfactory, while France and Greece with positive annual rates of 0.2 and 0.35 per cent consider these rates as too low? Why do the United States, Canada and Ireland, with rates between 0.8 and 0.9 per cent, regard these rates with satisfaction? If such perplexing findings were uncovered in an investigation of individuals, they would soon be followed up with depth interviews, focus group sessions and observational approaches better to explicate the typical cases and diagnose the deviant ones.

As we move to other regions, even greater anomalies surface. Although 30 African nations judged their growth rates to be too high, the Congo, Equatorial Guinea and Gabon, with annual rates of 3.2, 2.4 and 3.5 per cent, regard theirs as too low. Moreover, there are an additional 18 African nations that regard their rates as satisfactory despite the fact that all exceed 2 per cent (UN, 1992). The UN believes that the first three consider their nations to be underpopulated, so that rapid growth is seen as desirable. This could also be of importance in Argentina and Bolivia, whose rates of 1.3 and 2.8 per cent respectively, are viewed as too low. Follow-up in depth to ascertain who is doing what reasoning should be a high priority research item.

### 3.3. Content Analysis

Some of the problems of bias inherent in the direct query approach are circumvented by analyzing government documents intended for some other purpose. An example can be provided by examining what 169 governments said about population in their reports to the Rio de Janeiro Earth Summit Conference. The United Nations Commission on Environment and Population (1992) has published three volumes of summaries of these reports, which were usually prepared by special committees set up to prepare for the conference. Each of the summaries, which run 5-6 pages, contains a section on "Problem Areas" and a section on "Recommendations and Priorities on Environment and Development." We would expect population problems and recommendations to be found in these sections, if population is viewed as any kind of major factor in the environment.

The number of problems ranged from less than five (Singapore, North Korea, Myanmar and Cuba) to over 40 (Russian Federation, Pacific Islands), with a median number of 14 and with 75 per cent of the nations citing more than 10 problems. Despite this large number, a majority (54 per cent) failed to mention population growth or pressure as a

problem, and 28 per cent mentioned neither population growth nor distribution (i.e., urban concentration, city growth, etc.) (Table 1).

The data confirm the industrial nations' lack of concern about their population growth. Only six of the 42 nations of Europe, Northern America and Oceania mentioned population growth as a problem. Of these, four were from the former Soviet Union—Belarus, Estonia, Latvia and the USSR, the latter concerned over *declining* growth rates. The United States and Switzerland are the only other countries in this group.

**Table 1. Mention of Population Growth or Distribution as a Problem, in *Nations of the Earth Report* (UNCED, 1992)**

	Latin America/ Caribbean	Africa	Asia	Europe/Oceania/ USA/Canada	Total
Population Only	5	20	15	3	43
Urban/Distribution Only	15	6	13	9	43
Both	6	14	12	3	35
Neither	8	4	9	27	48
Total	(34)	(44)	(49)	(42)	(169)

On the other three continents, Latin American nations were the least likely to cite population problems (35 per cent), the African nations most likely (70 per cent), and the Asian countries fell in between (50 per cent).<sup>5</sup> Latin American countries were the most likely to cite urban growth or distributional problems (62 per cent), compared with Asian and African nations (49 per cent and 43 per cent, respectively).

Although the 169 nations made a total of 2,232 recommendations, only 31 countries or 18 per cent made a recommendation on population. These ranged from "coping with population growth" to "better family planning." Nearly all came from Asia (16) and Africa (12). In Latin America only Haiti, Bolivia and Trinidad made population recommendations. None of the industrial nations did so.

This kind of test of concern about population has advantages similar to those of open-ended questions in an individual questionnaire, especially where the respondent is unaware of the subject of the inquiry. However, despite guidelines, each country decided on the specific mechanisms for writing the report, making some responses more official or representative of decision makers than others.

#### **4. Measurement of Public Attitudes. The World Fertility Survey (WFS)**

The success of public policies can be greatly enhanced by information on public attitudes.<sup>6</sup> With respect to population, the World Fertility Survey (WFS) (and its

successor, the Demographic and Health Surveys) has been the largest cross-national survey in the history of social science. The WFS interviewed 341,300 women of childbearing age from 61 countries at a cost of \$47 million, at least \$5 million of which was from the LDCs themselves. Organized and monitored by a substantial staff of experts operating under the aegis of the International Statistical Institute, the survey was a model for its rigor in sampling, questionnaire design, data processing and report writing. Should it be the model for social science research on the environment?

Scholarly production was impressive in volume,<sup>7</sup> and the surveys greatly increased LDC capacity for conducting sample surveys. Moreover, there were several indications of policy payoffs. First, the survey enabled countries not yet sure of where they stood on the controversial issue of population planning to engage in an activity ("research") less subject to controversy but policy relevant.<sup>8</sup> It gave some breathing space to countries not quite ready to introduce population planning. Among the other ways in which the surveys contributed to policy were (1) demonstrating a large unmet need for contraception; (2) providing more accurate data on fertility, which tended to be higher than official estimates; (3) verifying that prevalence and duration of breast feeding were important factors in fertility; (4) showing that larger doses of education than had been supposed would be necessary to induce fertility declines (Gille, 1985).

A questionnaire sent to participating agencies at the termination of the surveys in 1983 specifically asked about dissemination and utilization of the findings. Nineteen countries reported that the findings were used in population projections (Ortega and Vaessen, 1987: 964-65), and "18 of the 19 countries with official family planning programmes made use of WFS findings in these programs; findings were also applied in 15 of the 23 countries with private family planning programs."<sup>9</sup>

#### 4.1. Limitations of the World Fertility Survey

Although the WFS proved useful to many countries, its shortcomings as a model for attitude surveys on environment and population need to be noted. First, in most countries the sample was restricted by gender, age and marital status. Especially problematic, even for a fertility survey, was the exclusion of males and of young, unmarried women. As regards environment, there are both theoretical and empirical reasons for considering younger cohorts as qualitatively different from older ones,<sup>10</sup> and any large scale survey should take care to include this population.

Second, the survey was essentially a-theoretical.<sup>11</sup> While much useful descriptive material was provided, the explanatory or predictive power of the study was weak.

Third, attitude data in the WFS are almost non-existent, essentially confined to a few items on desire for more children. No attitudes toward environment were included, nor were attitudes toward *demographic* aspects of one's community or nation.

Fourth, assessment of respondents' knowledge was confined to knowledge of contraceptive methods and their supply sources. Since demographic knowledge was not assessed, the study sheds no light on respondent awareness of government pro-natalist or anti-natalist policies, nor does it measure awareness of the population size, growth, density or distribution of the respondent's nation or community. Fifth, only 17 of the 42 countries included a community module, and most of these did not

analyze the data. Thus, situational determinants of household or individual behavior cannot be determined.

Sixth, there are very few potential explanatory variables in the WFS questionnaire. For example, there are no questions on agriculture (tenure, production, land use, size of plot, etc.) despite the fact that most of the respondents are living in rural areas; nor was information collected about sources of information on family planning (mass communications exposure, friendship networks, health professionals, etc). Migration data were excluded, as were details on women's working.

In 1984, the Agency for International Development (AID) initiated a new series of surveys--The DHS or Demographic and Health Surveys. By 1991, final reports had been received from 29 countries, with many more planned. In addition to new questions on maternal and child health, there are a few more attitude items on contraceptives and fertility intentions; sexual behavior (sexual frequency and age at first experience); migration; women's working experience; and exposure to mass communications. As in the WFS, however, there are no questions on demographic knowledge, attitudes and behavior, or on agriculture, the community, or the environment (Institute for Resource Development, 1990).

In sum, the WFS and DHS set some good examples in terms of overall design, methodology, and policy benefits, but provide little guidance on the *content* of future surveys on population or the environment. But another source of guidance on public opinion are the surveys carried out by professional pollsters, who are strongly policy oriented. What can we learn from them?

## 5. Two Decades of Public Opinion Polling

### 5.1. U.S. Based Surveys

Using computerized data (POLL) covering 150,000 questionnaire items from over 8000 surveys in the Roper Center Archives, Milavsky (1991) found that 2979 questions on the environment had been administered in US surveys 1935-90. From a mean of less than two questions per year until 1969, the average rose to 80 per year in the 1970s, 148 in the 1980s and 311 for the period 1990-92.

Using the same data set<sup>12</sup> I searched for questions on "population growth," "population size" and "overcrowding." Only 149 items were recorded in these categories, 96 per cent of them since 1970. Since then there has been no trend in annual numbers of references, i.e., population questions have been few and have not been increasing<sup>13</sup>.

### 5.2. Surveys from Other Countries

The twelve volumes (1978-79 to 1990-91) of the *The Index to International Public Opinion* consist of an annual inventory and exposition of questions used in "over 165 countries and geographical regions worldwide" (Hastings and Hastings, 1991: xi). Norris (nd) tallied 469 items on the environment from this source. Judging from this small number compared with the thousands tallied in the Roper Archives, the Index is

highly selective in what it chooses to include<sup>14</sup>. Nevertheless, it will give us some idea of the nature of the items and the relative attention given to population and the environment.

A search of the indices contained in the 12 volumes resulted in a total of 332 items broadly related to population.<sup>15</sup> Nearly half of these (156) were devoted to "family size," over one-quarter (91) to "birth control," and only about one-quarter (85 items) to attitudes toward population.<sup>16</sup> Almost one-third of the items occurred in the most recent three-year period. This recent upsurge, however, is almost entirely due to increases in questions on birth control and family size, while population items have remained constant at about five per year over the past decade.

According to the Index, France has asked the largest number of questions (57), followed by Japan (49), Great Britain (37), the USA (33), Germany (32), and Canada (24). After Canada, there is a sharp drop to the next set of 13 nations (3-9 items each), all of them industrialized with the exception of India. Most of the remaining 16 nations had asked only one question each.<sup>17</sup>

A number of conclusions can be reached, based on a review of the questions on population used in over 80 surveys:

1. Questions regarding population attitudes are fewer than those dealing with attitudes toward family planning and family size.
2. Few questions have been repeated over time in the same countries, and the same questions are infrequently applied across countries.
3. Data on the public's level of demographic information are especially sparse.
4. Responses reflecting degree of concern about population depend on question format and sequence. A very small minority (<5 per cent) spontaneously cite population problems as the highest priority; a larger proportion, up to one-quarter, believe they are among the world's major problems; and majorities say, if asked directly, that they regard them as serious.
5. Population questions usually refer to population growth or size. Very few questions refer to population distribution, composition, migration, or death rates.
6. Few questions on attitudes toward existing or potential population policies are found, other than with respect to abortion and family planning.
7. Attitudes toward the dynamics of community (as opposed to national or world) population dynamics have not been queried.
8. Personal behavior aimed at affecting population or population policies is virtually never queried; i.e., voting, organizational support, political activity, adoption or family planning for demographic purposes, etc.
9. Exposure to mass communications regarding population is rarely assessed.

## 6. Contemporary Polls on Population or the Environment

### 6.1. Population Polls

I am not aware of any recent surveys that have devoted a major portion of the questionnaires to population attitudes. However, there are several American surveys from earlier decades that should be reviewed.

The earliest American surveys on population were carried out in 1965 and 1967 by the Gallup Organization, under the sponsorship of the Population Council. A major finding concerned the public's lack of demographic knowledge: in 1965 only one-third could correctly estimate the size of the U.S. population, even when prompted and allowed a range of 25 million over or under the true figure. Less than one-third knew or guessed correctly that Brazil was growing faster than the United States, and only 15 per cent correctly guessed the number of years it would take to double the national population at current rates (Berelson, 1966).<sup>18</sup>

About half thought American population growth constituted a serious problem, and almost two-thirds so regarded the world's population growth. In the two years between surveys, a time of much media coverage, overall concern stayed about the same, but decreased relative to other social problems such as crime, poverty and racial discrimination. In both surveys, close to two-thirds thought the US Government should give birth control assistance to states and cities on request.<sup>19</sup> In 1971 a national sample of adults was taken for the US Commission on Population Growth and the American Future. It confirmed the low level of demographic knowledge: only 38 per cent knew China had the world's largest population, only 16 per cent could correctly state the world's population within one billion, and only 37 per cent correctly assessed US population size as between 175 and 224 million (Wolman, 1972).

This survey had several advantages over the earlier Gallup polls. First, it contained a considerable number of policy type questions: e.g., whether something should be done to slow population growth; whether the government should facilitate abortions, sterilization and sex education; whether it should use tax laws to motivate fertility or its control, encourage or discourage immigration, etc. Second, although there was little on the environment, a few questions *directly linked* it with population (e.g., whether or not population growth is the main reason for air and water pollution, whether population growth is the main engine of economic growth, whether it is using up natural resources too fast, and whether it is population or pollution that is the greater problem). Third, a few questions directly linked personal behavior with attitudes toward national demographic trends: e.g., whether the respondent would consider adopting a child, and whether people should limit fertility even though they can afford to have a large family. Finally, it contained questions on attitudes toward the size of the respondent's community. Deficiencies in the study include the absence of information on behavior itself, such as use of birth control, voting or organizational activity with population goals. Published analysis was limited to cross-tabulation, usually bi-variate.

The most recent American poll was carried out for the Rockefeller Foundation by the Gallup organization just prior to the 1984 World Population Conference in Mexico. It contained nine items largely dealing with attitudes toward population policy. The study

was not fully analyzed, but a press release accompanied by a series of cross-tabulations was issued at the conference (Segal, 1984).

## 6.2. Environmental Polls

Two multi-national surveys that are entirely focussed on the environment<sup>20</sup> have been carried out by Harris and Gallup in recent years.

*The Harris Poll.* This massive multi-national survey of public and leadership attitudes toward the environment was conducted for the United Nations Environmental Program (UNEP) by Louis Harris and Associates (1989). The questionnaire was administered in "31 separate surveys, conducted in 16 countries...whose populations account for more than 64 per cent of the world's population." The samples were designed to be representative of persons aged 16 and over, mainly those living in the "major metropolitan areas and urban centers, because of the impracticality of surveying rural populations" (Louis Harris and Associates, 1989: 2). In each nation 300 to 1250 persons were surveyed, plus a separate sample of 50 leaders. Quota sampling, random walk techniques, probability sampling, and electoral registers were variously employed.

The survey concentrated on awareness of and attitudes toward environmental issues. The most important conclusion concerned the "deep and widespread concern about the quality of the environment." This conclusion was based on such findings as "Most people in 15 of the 16 countries surveyed, rated the environments of their countries as only fair or poor." Such a conclusion is critical, for it could suggest that stringent government policies would be welcomed, if not demanded, by the publics in both industrial and non-industrial nations.

Apart from the fact that the surveys were highly variable in sampling size and design, they were drawn exclusively from major urban areas, with all this implies about literacy, general sophistication, and attitudes toward national issues. But there are more serious problems of bias with the sequence and format of the questions. The way in which the Harris questionnaire was introduced immediately tipped off respondents that the subject of the interview was environment, defined in a vaguely positive way: "Hello...We are conducting a survey of public opinion in this country and other countries about the environment—the world we all live in." The introduction was immediately followed by three items<sup>21</sup> eliciting an evaluation of the environment, which, again, was somewhat positively defined for the respondent as "the land, the sea, the air, the rivers and lakes and the climate."

In the questions that follow, "don't know" or "not sure" responses were accommodated in the coded response categories, but never incorporated as a response alternative into the questions themselves. This will inflate the proportions who appear to have an opinion.<sup>22</sup> Rarely are "not certain" responses reported as higher than 3 per cent, even in the LDCs. For the following question, which could confound the average college graduate, a mere 8 per cent of the total sample (and only 9 per cent in the four African samples) were reported to be not sure.

" If you had to make a choice between having building and industrial development which might endanger the health of some people but would make jobs for people and a better standard of living, or living conditions where the air was good, the

water was good, and the health of people was much better, which would you choose—a situation where there would be a better standard of living but with real health risks, or a less good standard of living but with much less risk to human health?"

When respondents have no opinion, are uncertain or ambivalent, they are especially susceptible to suggestion, that is, to loaded questions or to what they think the interviewer wants to hear. In the Harris survey there is considerable evidence of questions loaded in the direction of eliciting concern for the environment. For example, each of ten items on pollution is preceded by the phrase "*How much of a danger do you think that kind of pollution will be in your country in the next five years—very serious, somewhat serious, not very serious or not serious at all*" (emphasis added). Thus, in order to indicate lack of concern, a respondent had to deny the implied existence of a danger.

Most of the ten pollution questions, moreover, are vividly and negatively colored. For example, "How much of a danger is:

...drinking water that will make people sick?

...air which is polluted and makes breathing more difficult?"

Batteries of items follow, most of them further informing the respondent about specific dangers. Thus, a set that asks whether each of a number of items constitutes "a major problem, a minor problem or not a problem" contains such loaded examples (emphasis added) as:

"*The danger of radioactivity from nuclear power plants.*"

"*The dangerous use of chemicals used to control pests or weeds.*"

A set of eight agree–disagree items included such loaded statements as:

"Unless something is done urgently about controlling the environment in the world, the land will become desert, the oceans will flood over onto the land, and the earth will hardly be fit for human life."

"With industry dumping dangerous toxic wastes, people polluting the air with fumes from cars, and factories giving off polluted smoke, the health of future generations of children is in real danger."

In order to assess the balance of positively and negatively worded statements, I classified each of the survey's 102 substantive questions according to its loading. The examples I have already given illustrate *negative* loadings. An example of a positively loaded item (one in which environmental circumstances are favorable or non–problematic) would be: "People have always lived with some pollution in the air and water so why be upset by it now? Do you agree or disagree?" An example of a neutrally worded item is: "Do you feel the environment where you live has become better or worse in the last 10 years, or has it stayed about the same?"

*A tabulation of the 102 items found that 38 of them were neutral, 62 negative, and only one or two positive.*

*Population in the Harris Poll.* The Harris poll asks only one question on population out of the hundred odd items: "Do you think the growth of population has been a major cause, a minor cause or not a cause of pollution to the environment?" The same format was used for 10 subsequent items such as pesticides, the dumping of toxic chemicals

and the cutting of forests. In the unweighted total sample (7072 cases for all nations), population is at the bottom of the list as a major cause of pollution, along with soil erosion. Only 45 per cent of the combined public samples considered either of these to be a major cause of pollution, compared with more than 80 per cent for various kinds of industrial practices, 69 per cent for inadequate government policies, and 61 per cent for the failure of countries to cooperate. The same ranking holds among the sample of leaders, 50 per cent of whom judged population to be a major cause of pollution.

Some of the differences among nations do not appear unreasonable (Table 2). It is perhaps not surprising that India, with its lengthy record of population planning registered the highest level of public and leader perception for the importance of population; and it seems plausible that the nations with the slowest rates of population growth, such as the European, would have the lowest levels of public concern. Mexico's very high levels might be due to their extensive mass communication programs on population, as distinct from Argentina's pro-natalist policy.

**Table 2. Percent who "think the growth of population has been a major cause of pollution or damage to the environment," by Nation and Sample**

	General Public	Leaders
Argentina	36	18
Jamaica	47	46
Mexico	78	67
Brazil	50	48
China	37	34
India	79	80
Japan	39	56
Saudi Arabia	37	35
Kenya	70	66
Nigeria	40	36
Senegal	58	36
Zimbabwe	56	78
Hungary	22	27
Norway	30	62
W. Germany	39	54
All Countries	45	50

Source: Harris, 1989

Less credible, however, is the low significance attributed to population in China, where both leaders and the public have been heavily saturated with population control propoganda. That China is at the same level as highly pro-natalist Saudi Arabia strains credulity, as does population's high ranking in Kenya. Of course a single question is not to be trusted on any survey, and the diverse sampling designs in this survey could

also be responsible for such differences. More detailed analysis of the data (e.g., controlling for social and economic characteristics) might also help to account for them.

*The Gallup Survey.* In 1992, a second cross national opinion survey of mammoth proportions was carried out, this time under the sponsorship of the Gallup International Institute. "Representative national samples of 1000 or more citizens" were interviewed in 24 nations around the world, the project funded by governments, foundations, business organizations and Gallup affiliates (Dunlap, Gallup and Gallup, 1992). The questionnaire is much superior to Roper's and avoids many of the problems of question loading discussed above. A most important distinction is that its first question, prior to any information as to the subject of the interview, is an open-ended one that asks the respondent to name "the most important problem facing our nation today." This format enhances the analyst's ability to assess the priority level of environmental concern, before potential contamination by batteries of questions on the environment. In response to this question, no more than about 10 per cent of the samples in Northern America, Russia, Germany, Great Britain, Hungary, Poland and Norway mentioned environmental problems. This is by no means a trivial proportion, but yields a much different picture than is gained from direct questions asking the respondent for the degree of his/her concern. Moreover, in the one country (Ireland) where respondents were aware, prior to the questions, that the subject of the study was the environment, 39 per cent mentioned environment as the number one problem.<sup>23</sup>

The Gallup survey did in fact ask respondents to rate how serious a problem they considered environment to be, but also asked the same questions about crime, the economy, health, prejudice, and homelessness. Thus, the finding that majorities in 12 of the 22 countries rated environmental problems as "very serious" becomes far more meaningful when we discover that in 11 nations environment is among the three most highly rated problems and in none is it the lowest rated problem.

The Harris survey's second question ("How would you rate the environment in this country--excellent, pretty good, only fair, or poor?") was very similar to Gallup's second question ("Overall, how would you rate the quality of the environment of our nation--very good, fairly good, fairly bad or very bad?"). The Gallup study reports only the percentages who responded "Fairly bad or very bad" so that I will compare these with Harris respondents who replied "only fair or poor" in the eight countries surveyed by both agencies (Table 3).

**Table 3. Percentages Who Think Their Nation's Environment is Poor, Harris and Gallup Compared**

	Harris Percent "only fair or poor"	Gallup Percent "fairly bad or very bad"	Harris Percent "poor"
Brazil	80	49	29
Mexico	85	55	51
India	83	51	48
Japan	83	52	27
Hungary	85	72	39
Germany	83	42	30
Norway	55	11	13
USA	64	46	20

By this comparison, far more concern about the environment is expressed in the Harris survey, in which respondents were informed about the nature of the interview.<sup>24</sup> In most instances this difference is about 60 per cent (30 percentage points). In the case of Germany, twice as many express concern, and in Norway five times as many.

Of course, the Gallup study is based on national samples, while the Harris subjects are urban; but in the case of India the Gallup sample happens also to have been 90 per cent urban and the differences are just as large as in countries where the sample included rural populations. It could be argued that Gallup's "fairly bad and very bad" reflects more concern over the environment than the Harris' "only fair or poor," and that the Harris equivalent should be "poor." By this measure, concern drops radically in the Harris sample, and, in five of the eight countries, falls below concern as expressed in the Gallup survey (Table 3, Column 3).

We may conclude that the measurement of "concern" can be much affected by the study's introduction, and that slight changes in question wording or categorizing can have major impacts on the conclusions. Concern for the environment is widespread, but not so intense as the Harris data and conclusions imply.

*Population in the Gallup Survey.* Something of an exception to the general neglect of population in environmental polls is found in the Gallup survey, since it included four questions on attitudes toward population. Early in the questionnaire (question 5), respondents were asked the open-ended question "What is the most important environmental problem facing our nation?" In none of the 22 nations was population mentioned most often or second most often; and only in India was it the third most frequently mentioned problem. Either population is not viewed as a priority problem of the environment, or it simply is not associated with *environmental* problems.

Some light on this is provided by a subsequent question in which six "possible causes of our nation's environmental problems" were read to the respondent, who was asked how much each "contributes to environmental problems here in our nation—a great deal a fair amount, not very much, or not at all." The first problem listed was "Overpopulation—there are too many people using up resources."

Using data from Dunlap, *et al.* (1992: Table 4), I classified seven countries as LDCs (India, Philippines, Turkey, Chile, Mexico, Brazil and Korea) and 15 others as more industrialized. In the average LDC, 50 per cent believe overpopulation contributes a great deal to national environmental problems, as compared with only 15 per cent in the other countries (unweighted means). Compared with the other five problems, overpopulation scores highly among the LDCs, but comparatively poorly among the industrial nations. This suggests, first, that overpopulation is not readily associated with environmental problems for most respondents. However, when population is identified as an explicit alternative, LDC respondents rate it as a very important contributor to environmental problems in their nations, while respondents in the more developed nations do not.<sup>25</sup>

While the Gallup questionnaire is clearly superior to the one used by Harris, the questionnaire seems too difficult for illiterate or semi-literate respondents. Unfortunately, proportions of non-responses and "don't knows" have not been reported thus far. My supposition is that the samples are biased toward upper educated respondents in the LDCs or that there are unacceptably high proportions of non-responses.

## 7. The Neglect of Population in Recent Surveys

Despite the volume of data gathering that we have seen devoted to the environment, a recent review concluded that:

"The work that has been accomplished to this point does not constitute adequate base-line data. It does not provide comprehensive coverage of countries or topics. The questions that have been used are seldom comparable on a global basis. The sample frame has been based on political and administrative boundaries with the result that the samples cannot be used to address many environmental issues. Most of the work to date has been primarily descriptive, designed to measure public concern about different environmental problems. Few of these surveys have been designed to explore changes in attitudes and behavior" (Jacobson and Miller, 1993).

As inadequate as they may be, poll data on the environment are nonetheless stronger than they are on population. Although questions and surveys on the environment have blossomed in recent years, questions and surveys on population have not. An examination of recent polls on environment finds them short on population:

In 1992 the ISSS (International Social Science Survey) conducted a 21 nation poll that contained 130 items on the environment. Items ranged from attitudes toward astrology to animal rights, but no attitudes toward population were included.

A British survey by MORI in 1990 queried respondents about 18 environmental problems ranging from destruction of tropical forests to uneven pavements. Population as a problem was not included. Similarly, MORI surveys of British MP's and MEPs attitudes toward the environment have not included population attitudes. Three 1990 MORI surveys contained 16 environmental behavior items that ranged from avoiding chlorine-bleached nappies to buying free-range eggs. Population-relevant behavior has not been included (Worcester, 1993).

Eurobarometer polls in 12 European countries have asked about personal behavior that might directly or indirectly affect the environment; e.g., littering, financial support for environmental associations, etc. Population-related behavior was not included.

In a review of *longitudinal* poll data, Dunlap and Scarce (1991) unearthed a total of 46 environmental questions that have been administered by nine major US pollsters.<sup>26</sup> Population was not among the questions.

Also in the USA, Cambridge polls in 1987 and 1989 asked respondents to register their degree of concern for a list of ten "potential environmental threats" ranging from pesticides to greenhouse effects. Population growth or density was not listed as one of the threats (Dunlap, 1991: 111).

## 8. Conclusions

According to one authority "Several forces are converging to create powerful pressures for conducting research on links between population growth and environmental quality" (Preston, 1993: 600). In this paper, various aspects of the knowledge base for such

research have been appraised and found to be weak. This is especially true of the links between population and environment, which have received little scholarly attention, but it is also true for the study of population, where productivity has not kept pace with that of the environment.

In terms of public awareness, poll data are highly vulnerable to sampling and questionnaire defects, but available evidence suggests that environmental awareness and concern are more widespread than population concern. The population–environment linkages, probably poorly understood by the general publics of most nations, are often ignored by governments, indicating the need for more research on (if not education of) decision makers.

To facilitate policy, better data and analyses of public and elite opinion on population and the environment are needed. *Both* topics should be contained in the same instruments, and the instruments and sampling designs should be replicated in a substantial number of industrial and non–industrial nations.

As for population, greater concentration is needed on attitudes toward demographic variables such as growth, size, distribution and migration. Such variables should refer to world, national, and community levels. Information on behavior motivated by *demographic* norms and attitudes is also needed.<sup>28</sup>

Analysis must move beyond descriptive statistics to include multivariate methods. The degree of consistency among various techniques such as content analyses, direct queries and expert assessments needs systematic evaluation.

The World Fertility Survey, with its carefully designed samples and questionnaires, can provide a general guideline for a world public opinion poll on population and the environment. Its shortcomings need not be repeated, and the lessons learned from the deficiencies of other poll data should be helpful in creating a superior multinational survey of population–environment knowledge, aptitude, and practice (PEKAP).

## Footnotes

<sup>1</sup>"Sociofile abstracts journal articles in the field of sociology and related disciplines, such as anthropology, economics, education, medicine, community development, philosophy, demography, political science, social psychology and planning. Coverage is international" (Dialog, 1986).

<sup>2</sup>Popline's coverage includes demography, human fertility, censuses, economic and social characteristics, biological characteristics, population policy and maternal and child health. It includes unpublished reports and foreign language publications. "Global" is the more inclusive search, and corresponds roughly to "Basic Index" in Sociofile. "Keyword Major" identifies the major theme of a publication and is roughly comparable to Sociofile's "Descriptor".

<sup>3</sup>Some critics have even expressed doubts about the depth of commitment of international donor agencies best known for promoting population policies. Thus, Lester Brown (1991: 17) has stated that "the World Bank officially recognizes the need to slow population growth, but contributes little to doing so. The Secretary–General of

the United Nations rarely mentions population, much less provides leadership on the issue."

<sup>4</sup>"the reported scores represent the authors' best judgment as to the score indicated by the data received...instead of taking the average of all answers..." (Lapham and Mauldin, 1985: 122). Whether this is an advantage or a disadvantage depends on the expertness of the experts.

<sup>5</sup>The only major Latin American countries that mentioned population growth were Mexico, Ecuador, El Salvador and Guatemala. Among the African minority that failed to mention population problems were South Africa, Chad, Zambia, Zaire and the Congo. In Asia, Thailand, Turkey, Iraq, Jordan and North and South Korea are among those that failed to mention population.

<sup>6</sup>These are occasionally assessed by content analysis. For example, Wilmoth and Ball (1992) traced U.S. opinion on population 1946-1990 by content analyzing a sample of 548 magazine articles that were among the 1683 on population they found indexed in the Readers Guide to Periodical Literature.

<sup>7</sup>All 41 internationally funded LDC surveys, and most of the others, produced detailed national reports. Moreover, the central office produced about 80 scientific reports, 50 multi-national comparative studies, 11 technical bulletins, 12 methodological studies, and "at least 500 analytic projects based on WFS data" (Cleland and Hobcraft, 1985: 3). At the very least, "these papers probably contain more information about the practical methods of survey taking and interviewing in developing countries than has been published in any previous enquiry" (Grebenik, 1981: 25. Cited by Blake, 1983: 154).

<sup>8</sup>At first the issue was considered to be so sensitive that policy objectives were not explicitly mentioned in the original design of the project, since "a strong emphasis on the role of WFS in providing much needed data for policy-making in the population field could have limited the response from countries and the full collaboration of the necessary local institutions and personnel" (Gille, 1985: 273).

<sup>9</sup>Among the specific policy consequences for particular countries, drawn from Scott and Chidambaram (1985) are: (1) The National Family Planning Association in the Dominican Republic based a new program on the strong demand for female sterilization revealed in the WFS; (2) data proving extremely high fertility in Kenya precipitated the creation of the Integrated Rural Health Family Planning Program; (3) the Turkish Ministry of Health used WFS data to win Parliamentary support for a law on family planning; (4) WFS results in Cameroon and in Nepal helped move these governments to form National Population Commissions; (5) The discovery of surprisingly low rates of contraceptive prevalence in Pakistan were influential in the formulation of its Sixth Five Year Plan.

<sup>10</sup>Based on a wide variety of survey findings, age may be the most critical demographic variable in accounting for variation in environmental attitudes and behavior (Black, 1993). Further, attitudes on the environment may be shaped (or more easily shaped) during formative years, and young people provide a readily accessible target to policy makers (via schools and youth organizations).

<sup>11</sup>Miller and Jacobson (1992: 177) argue that "An important theory--the theory of demographic transition--provided a framework for the survey," but this theory is too general to have provided much guidance.

<sup>12</sup>POLL is produced by the Roper Center for Public Opinion Research. Despite the large number of polls covered in the Roper Center Archives, not all commercial agencies share all of their data with the Center.

<sup>13</sup>Public interest in population may have been waning during this period. A content analysis of articles on population in American magazines found a decline in the number of articles on population from about 1970 on. However, among the articles devoted to population, the topic of population and the environment "goes from being a non-issue in 1946 to being the single most frequently invoked anti-growth argument in the 1980s" (Wilmoth and Ball, 1992: 651. See footnote 6.)

<sup>14</sup>According to the editors, "The data are drawn from surveys...by polling organizations which, in the judgment of the editors, are engaged in research of the highest scientific quality..." (Hastings and Hastings, 1991: xi).

<sup>15</sup>Some surveys have been multi-national, such as those sponsored by the EEC and Gallup International. In such cases, where the same question has been used in a number of nations, the same item has been counted several times.

<sup>16</sup>The birth control category includes attitudes toward abortion, sterilization, the pill, family planning commercials and government expenditures on family planning. Family attitudes include ideal family size, desire for more children, adoption, spacing, etc.

<sup>17</sup>These countries include Spain, Austria, Norway, Finland, Sweden, USSR, Hong Kong, Korea, Taiwan, Philippines, South Africa, Gabon, Peru, Chile, and Colombia. With less than one-fifth of its items dedicated to population, the USA is near the bottom, while Canada, with 45 per cent, is at the top.

<sup>18</sup>The correct response was 50 years. Responses 45 to 60 years were considered correct.

<sup>19</sup>Concern was about the same for Catholics and non-Catholics, but was higher among the better educated in both surveys (Kantner, 1968). The latter relation could be explained by superior demographic knowledge on the part of the better educated, but the hypothesis was not tested. A similar blind spot occurs in an analysis of two other national samples of married women in the U. S. National Fertility Surveys of 1965 and 1970. Finding very low levels of demographic knowledge in both samples, the analyst concluded the "the fact that only one respondent in four knew or could guess the correct size indicates that attitudes about population growth are not being informed by knowledge of the size of the population" (Rindfuss, 1972: 465). However, since a cross-tabulation between knowledge and attitudes was not reported, the irrelevance of the former cannot be assumed.

<sup>20</sup>In addition to polls by Gallup and Harris, a multi-national survey has been conducted by the International Social Science Survey, but results are not yet available.

<sup>21</sup>The third of these items ("How would you rate the environment in this country--excellent, pretty good, only fair, or poor") is of special significance, since the report leans on responses to it for the conclusion that the survey revealed "deep and widespread concern".

<sup>22</sup>Question wordings also failed to include critical middle positions as alternatives. Thus, nine items ask how things will change in the next 50 years, but allow only two alternatives: "Will there be more or less deserts? Will there be cleaner or dirtier air? Should this country be doing more or less...to protect the environment...?" (emphasis added). Responses to such questions tend to understate the degree of indifference or uncertainty.

<sup>23</sup>Although it is likely that Ireland's high degree of apparent concern was influenced by fore-knowledge of the subject, one other of the 22 countries (the Netherlands) also rated environment this highly, presumably without such knowledge. In these countries and one other with a relatively large proportion citing environment as the number one problem, smaller proportions rated environmental problems as "very serious." Thus, in the Netherlands, although 39 per cent mentioned the environment as the most important problem, only 32 per cent felt environment was a "very serious" problem. In virtually all other countries, far higher proportions regarded environment as a very serious problem than volunteered it as the most important problem. Examples are the U.S. (51 per cent and 11 per cent, respectively) and Poland (66 per cent and 1 per cent, respectively).

<sup>24</sup>The two polls agree on only two points: in both surveys Norway shows the lowest concern about the state of its environment, and, within each poll, the levels of concern among the three LDCs are about the same.

<sup>25</sup>Another question asked how much overpopulation, consumption of resources, and multinational companies contributed to environmental problems in LDCs. In most countries, substantial proportions rated overpopulation as contributing "a great deal" to environmental problems--an average of 47 per cent in the seven LDCs, and 38 per cent in the 15 others (Computed from Table 10, Dunlap et al., 1992).

<sup>26</sup>In an early review of those analyses that have reported correlation coefficients for environmental variables, Van Liere and Dunlap (1980) found only one population scale among 21 studies.

<sup>27</sup>Barnett (1970: 59) found that among a small sample of American women, there was only a moderate correlation between demographic concerns and the belief that couples should restrict fertility to avoid overpopulation. In 1970 he predicted that "a strong correlation will develop by the mid-1970s...stemming from the continued pollution of the environment with people and chemicals." It seems time to test the hypothesis.

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## CHAPTER 10

# POPULATION DYNAMICS, ENVIRONMENT, AND CONFLICT. WHAT ARE THE CONNECTIONS?\*

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### 1. Introduction

Population dynamics is a discipline that deals with the determinants and consequences of changes in the structure, growth and distribution of populations over time. By structure we mean the distribution of a given population by age and gender. There are two concepts of population growth. The first relates to total change in population relative to a base population size. Total change includes the balance of births, deaths and net international migration in a given period of time and within a given national boundary (conventionally called the rate of population growth). The second is being defined as the natural rate of population growth. This natural rate of population growth focuses on differences in the vital rates of births and deaths, and excludes migration as a source of increase or decrease in population size. Indeed, in the case of a "closed population," the two rates are equal. Distribution refers to the spatial distribution of population within a national boundary, such as rural-urban or regional balance within a country. It also relates to measures of density. As will be evident from the following discussion, population growth, structure and distribution constitute a consistent and interrelated demographic sub-system of society. They are also an integral part of the larger social, economic and environmental system.

The purpose of the present paper is to investigate the role of these basic demographic phenomena as a source of social and political conflict or disorder. Harmony and order, we must emphasize are not the norm in a world of continuous and accelerating changes in technological and environmental conditions. Many of these changes are not being confined to their areas of origin. Furthermore, not all changes are predictable. Many could be sudden and radical. Recent development in the super-highway information technology is an example of such rapid technological change with many unexpected and as yet unforeseen socio-economic and political ramifications. Uncertainty about changes in environmental conditions is illustrated by the case of the Greenland ice cores. Systematic observations of these cores questioned the conventional view of the stability of climatic conditions over long periods of time. Based on such observations, it has been concluded that climate can change suddenly and radically. Will we have time to adapt to such unforeseen environmental and technological changes, especially where many of the consequences seem to have no respect for national boundaries? What is the role of population change, as a cause and effect, in this process of universal change? More specifically, do population change

and structure reduce the adaptive capacity of the system? These are the questions that lie at the core of the present discussion.

By the adaptive capacity of the system we mean the extent of society's technical and social sustainability. Technical sustainability implies the ability of society to maintain over time the productive capacity of its core resource endowment. Social sustainability implies the harmonious evolution of its social contracts and of the institutions necessary for the enforcement of these contracts, within and across generations, in the face of such changes. The dichotomy of the adaptive capacity of the social system into technical and social spheres parallels that of the material and cultural antecedents of institutions. As Geoffrey McNicoll (1994:6) put it:

"Institutions .. emerge or are designed as ways for people to deal with recurrent problems about material realities (resources, technologies, environmental conditions, human biology) and as manifestation of ideational systems that give some degree of coherence in the cultural domain of symbol and belief."

The main argument of McNicoll (1994:7) is that institutions are path-dependent. They are:

"A precipitate of time. They adjust (admittedly with some delay, and at times only, so to speak, with considerable provocation) to changing circumstances -- say, shifting power relations among social groups or altered transaction costs. But the direction in which they adjust depends not merely on those new circumstances but also, and crucially, on their past history."

From the perspective of the present discussion, the adaptive capacity of society, especially as it relates to conflict is a function of the mechanism by which institutions evolve. The question as to how institutions evolve is yet unsettled. The recent research program in sociology (e.g. Hechter, 1983), seems to be, on the one hand, an attempt to indicate the universality of a standard explanation or theory to all institutional settings, and on the other hand an overly optimistic program. The parallel in economics is the attempt to impose the atomistic Newtonian paradigm of the equilibrium of forces, with possible growth but no genuine qualitative change in society, as the universal explanation of social and economic evolution. In this paradigm, social structures are incidental. They are merely the children of a system of micro-behavior that is always consistent, optimal and independent of time. Recent literature on the behavior of government as a social and political institution is illustrative of the incidental nature of structures in this paradigm. In that "positive" framework, the evolution of government is a result of "agents" maximizing behavior, that is to maximize their length of stay in power or their budget, subject to existing resource and power constraints. These constraints are set by the existing distribution of wealth and political power! Indeed, under special conditions of perfect competition in the economic and political domains, this type of atomistic and collective welfare maximum may coincide. The world is imperfect, however. The causes of the imperfection are outside the paradigm. Understanding the sources of the constraints, whether economic, social or political is the study of the structure of institutions. In the absence of such analyses, development is reduced to atomistic behavior on the margin.

The limitation of the atomistic paradigm has been discussed extensively in the literature. A recent critical overview is in Floyd B. McFarland (1991). Many economists have been wary of the universal application of standard theory to development

economics. This is best illustrated by Nicholas Georgescu-Roegen's (1971) statement in his classic work *The Entropy Law and the Economic Process* where he warned against the indiscriminate application of the Newton-Smith equilibrium paradigm, especially to the case of developing countries:

"For the tenacity with which we cling to the tenet that standard theory is valid in all institutional settings--either because its principles are universally valid or because all economic systems are mixtures of some invariable elements--has far-reaching consequences for the world's efforts to develop the economy of nations which differ in their institutions from the capitalist countries. These consequences may go down in history as the greatest monument to the arrogant self-assurance of some of science's servants."

The focus of the paper is to examine the role that population dynamics play in influencing such adaptive ability. Our main claim is that social and political conflict is a function of the adaptive capacity of society. We argue further that the effect of population change on society's adaptive capacity is context-specific. No general theory exists that encompasses all situations. The real world is inconveniently complicated. Analyses can only produce conditional conclusions that are short of universal generalizations.

The effect of population change on society's adaptive capacity depends, among other things, on the structure of the social and political systems. That structure includes for example, the degree of society's ethnic and cultural homogeneity and the degree of equity in the distribution of its income, opportunities and political power. The effect of population change depends equally on the ability of existing institutions to introduce necessary changes and, meanwhile, have themselves the capacity to adjust to such changes. We agree that the evolution of institutions is path-dependent. The atomistic Newtonian paradigm needs elaboration as to how history, present circumstances and expectations interact to influence institutions through the aggregate of individual decisions and behavior. There are three sets of institutions that, for purposes of the present discussion, define the social structure of society: namely government and governance as well as economic and social institutions.

First, we present an overview of population trends. This is followed by a review of potential mechanisms through which conflict may arise. Next, we discuss three illustrative case studies from Sub-Saharan Africa, South Asia and the Middle East. Finally, we present some general conclusions.

## **2. Population Trends and the Demographic System**

In this section, we review some key population trends. The review serves as the basis for interpreting the consequences of these trends. To facilitate the discussion we define demographic concepts as we go along and introduce some basic demographic system identities. The relation between population change and conflict is a policy-oriented subject. Policy analyses include four levels: descriptive, explanatory, predictive and evaluative. Formal Demography provides the tools and technical language to measure and describe the levels, movements and interrelations among the three basic components of population change: mortality, fertility and net migration.

Descriptive demography also provides population projections. These are essentially scenarios that specify, given the initial age structure, the boundaries and limits within which population change could occur over time. The level of explanation, prediction or the cost-benefit evaluation of demographic phenomena, however, is beyond the basic tools of technical demography. Here demographic analyses must join hands with a large number of other methodologies and disciplines that range from biology, economics, and sociology to political and environmental sciences. We start with a simple framework to formalize the discussion.

A simple but fundamental demographic accounting identity relates population growth  $r(p)$  to its basic components as follows:

$$r(p) = \text{Crude Birth Rate} - \text{Crude Death Rate} + \text{Net Migration Rate, or} \\ [1] \quad r(p) = \text{CBR} - \text{CDR} + \text{NMR}$$

Clearly, the size of  $r(p)$  depends on the difference between the two vital rates of birth (CBR) and death (CDR), assuming international migration (NMR) is not a significant factor. Not immediately obvious, is the presence of a direct relation between the level of fertility and the age structure (or the age pyramid).

High fertility that persists for a few generations produces a young age structure where the bottom of the age pyramid is fairly wide. In this situation, the young, say those under age fifteen, compose a large proportion of the population, typically 40 per cent or more compared to about 20–25 per cent in societies with older age distributions. While the old, say 65 and older, make up less than 5 per cent of the total population compared to 15–20 per cent in older age structures. This pattern of high fertility and young age structure has been the typical case in almost all the developing countries through the 1970s. With fertility continuing at relatively high levels, the remarkable decline in mortality that started in the 1950s did not have a significant effect on the young pattern of the age distributions in the developing countries. Its main effect has been to produce high rates of population growth (World Bank, 1993, 1994).

A systematic decline in fertility in some developing countries started in the late 1970s. It was led mainly by East Asian countries: Korea, Taiwan, China, Hong Kong and Singapore experienced a remarkable decline. These were joined more recently by Thailand, Malaysia and Indonesia. By the late 1980s, fertility in most of the developing countries, regardless of the level of their development or cultural background, seems to have started a sustained decline. On the whole, birth rates have declined by one-third since the mid-1960s: women formerly had six children on average, but only four by the beginning of the 1990s. This apparent trend led some observers to conclude that:

"The developing world is undergoing a reproductive revolution. In contrast to the classical demographic transition, recent evidence suggests that birth rates in the developing world have fallen *even in the absence of improved living conditions. The decrease has also proceeded with remarkable speed. Developing countries appear to have benefited from the growing influence and scope of family-planning programs, from new contraceptive technologies and from the educational power of mass media.*" [Emphasis added] (Robey, Rutstein and Morris, 1993).

Some observations on this 'reproductive revolution' are in order.

1. These trends are not universal. As indicated in Figure 1, the decline in fertility has been lagging in some regions and countries, i.e. Sub-Saharan Africa and some Arab and South Asian countries. Indeed, such variations are expected, as illustrated, for example by McNicoll's (1994:26-34) five fold typology of broad patterns of fertility transitions. Variations depend on how institutions adapt.
2. Despite the observed decrease in birth rates, the world population will continue to grow at high rates. It is expected to double to 10 billion by 2050. For some countries the increase will continue well through the middle of the next century.
3. The reason for the large increase in population size in the face of declining fertility rates is the momentum built into the young age structure of the populations of the developing world. For example, if India adopts a replacement level of fertility immediately, its population will continue to grow until the sizes of its various cohorts equalize, thus reaching a stationary state. In this transition, India's age structure will change from its original young triangular shape towards a stationary rectangular shape, as illustrated in Figure 2.
4. Moving from a young age structure, typical for all developing countries, towards a stationary state, a population will increase in size. That increase will be greater the younger the initial (stable) age structure. Furthermore, that increase in population size will be concentrated in that part of the population above 30 years of age. This process is illustrated in Figure 2 for the case of India. In this hypothetical case, between 1995 and 2025, the size of the 30-35 age group can be expected to increase from about 70 to 100 million people. In this scenario, for those who are less than ten years of age, population size declines from about 230 to 210 millions (Kim, Schoen and Sama, 1991).
5. The socio-economic significance of the concentration of growth in the older age groups (over thirty years old) needs no emphasis. It is probably a major potential source of conflict in the process of population change. It increases the supply of potential workers in society. It also increases the relative claims of the elderly. If output and productivity do not increase fast enough, unemployment and potential inter-generational conflict may arise.
6. Concentrating on fertility and its effects on the age structure ignores other important consequences of fertility decline. An established high level of fertility reflects a structure of local values, traditions and social contracts. That structure represents the foundation and stability of the existing social and political order. It implies an established distribution of income, wealth, power and authority. New patterns, especially those perceived as foreign, pose serious challenges to the privileged status of the existing authorities. Such challenges do not proceed without resistance. It is emphasized that even in social structures that have been established for long periods, values are not universal. At any time, there exists a certain degree of value heterogeneity. This should not be confused with the continual changes in the overall value system being induced through innovations and technical change. The policy challenge is to maintain the diffusion of social innovations within the ability of society to absorb its new value implication. That challenge is not always met.

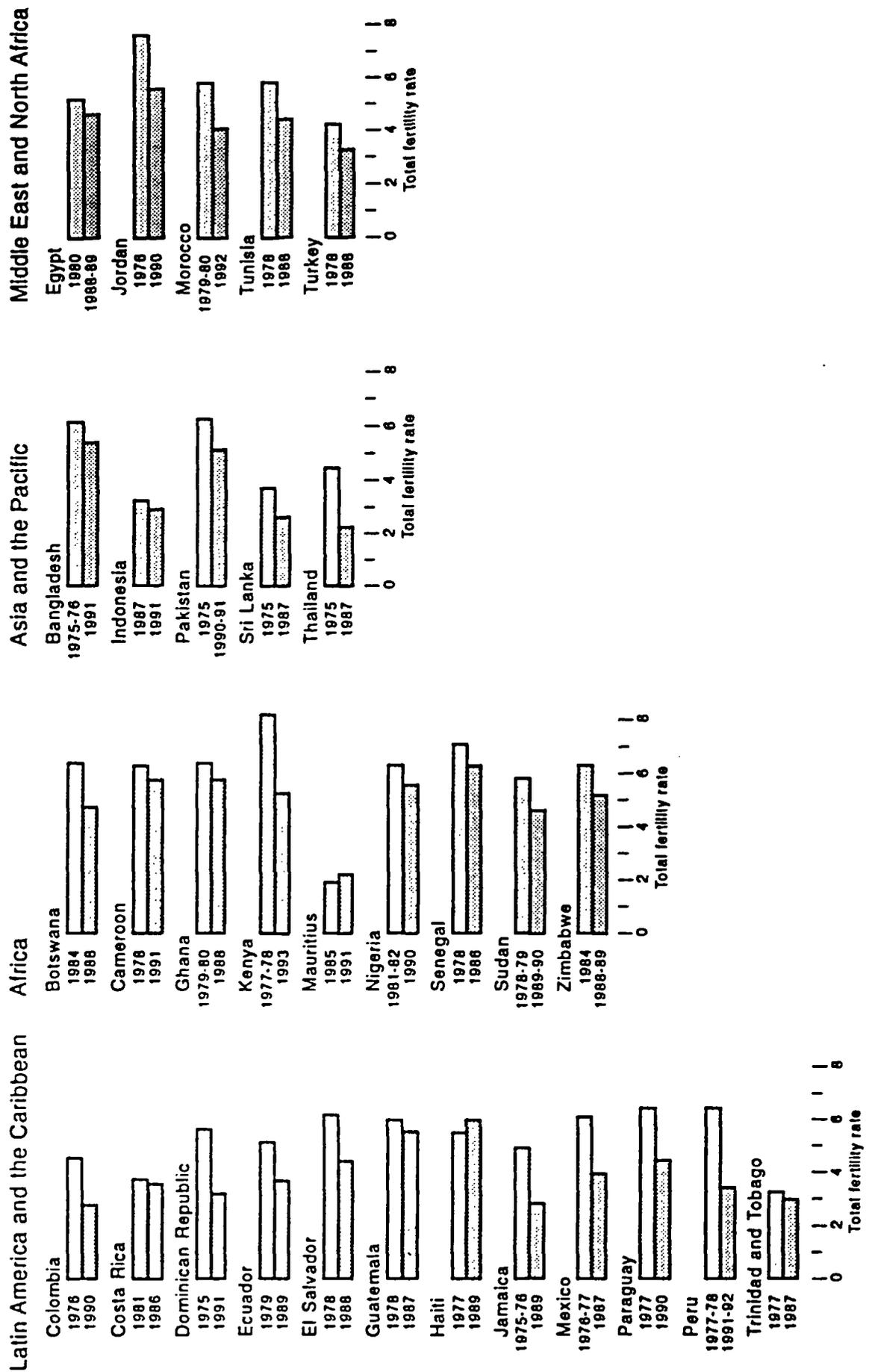


Figure 1. Recent changes in fertility rates in some developing countries, after Robey, Rutstein and Morris, 1993.

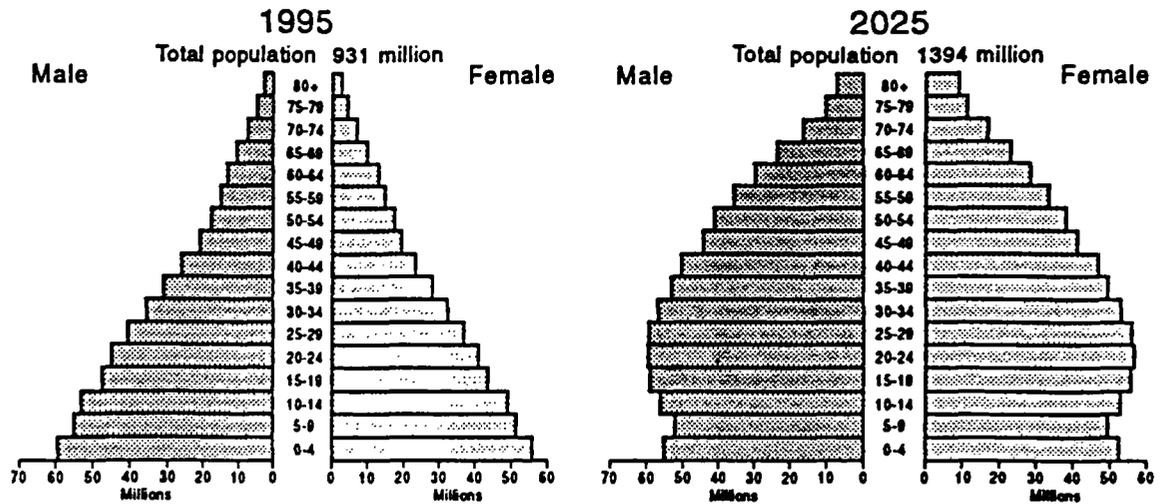


Figure 2. Projected age structures of India, 1995 and 2025, after UN, 1993.

"If such development-induced change proceeds too fast, relative to the ability of the social system to absorb it [to become endogenous to society], resistance to change may turn into revolt against change and ignite revolution against the established regime. The result of these dynamics could be *the emergence of a new development paradigm that builds upon threatened traditions, or an attempt by the established regime to accelerate the process of change...* Established regimes may fear the loss of legitimacy and may divert scarce resources to security issues through costly repressive means or through a non-sustainable system of subsidies and employment guarantees, away from their countries' long-term development priorities. Alternatively, established regimes may seek alliances with foreign powers that, on the surface seem to be an attempt to accelerate the modernization effort, but mostly are an attempt to seek protection against the opposing forces that represent established traditions" (Sirageldin, 1992:50).

7. Migration is the third element in the demographic accounting of Equation 1. Migration is probably the most important population factor underlying the overall stability of the socio-economic system – at least in the short run. For example, resistance to change depends on:
  - "...the structure of the social system, the degree of its openness, e.g., acceptance and assimilation of immigrants. A tribal social system, a commune-canton Swiss-type system, or a subsistent rural community are examples of relatively closed systems with strict socialization processes that limit the domain of individual actions" (Sirageldin, 1992:50).

The acceptance of controlling immigration as a legitimate exercise of national sovereignty is not much disputed in international law and relations. Such movements whether legal or not do occur, however, on a large scale. In many instances the results created conflict and violence. For example, it is estimated that in 1992, there were 21.6 million refugees around the world. These were distributed as follows: 9.89 million

refugees in Asia, 5.39 million in Africa, 4.38 millions in Europe, 1.04 million in North America, 0.89 million in Latin America and 0.06 million refugees in Oceania (Population Action International, 1994). Movements of refugees are partly a result of conflict in areas of origin and a cause of conflict in areas of destination. The sovereignty of the national state to regulate such movements is not disputed as mentioned above.

The exercise of the state role in the internal distribution of population has not been free from conflict. It must be noted, however, that although the economic and social consequences of migration seem current and visible, its determinants could be a result of deep rooted historical foundation. It could be triggered by unexpected and sometimes irrational incidences creating costly conflicts. There are many such examples in recent history as well as in today's world. The role of migration as a source of conflict is examined below. First the relation between population change and conflict is examined on the conceptual level.

### 3. Modeling Population Change and Conflict

#### 3.1. Population and Development

It was noted earlier that population dynamics is a subsystem of the larger socio-economic system. The demographic identity of Equation 1 could be incorporated in a larger identity that relates population growth to the growth rate of national output. That latter rate includes the rate of net human and physical capital accumulation as follows:

$$[2] \quad r(p) = r(Y) - r(y)$$

$$[3] \quad r(y) = \{S/K\} - \{CBR - CDR + NMR\}$$

$r(p)$ ,  $r(Y)$  and  $r(y)$  refer to rates of growth of population, GNP and per capita GNP respectively.  $S$  and  $K$  refer to the saving ratio and the incremental capital output ratio. (For details and references, see Ismail Sirageldin, 1991).

On a descriptive level, the Left Hand Side of Equation 2 indicates net human capital formation and the Right Hand Side indicates non-human capital accumulation. Equation 3 illustrates that to maintain the same standard of living [ $r(y) = 0$ ], invested saving [ $S$ ], and productivity [ $K$ ] must accommodate net additions to the population [ $r(p)$ ].

However, development implies more than accommodating net additions at the same standard of living. It implies an attempt to improve living standards for present and future generations. Representing the gap between current and desired status by  $d$ , Equation 4, represents required system adjustments as follows:

$$[4] \quad d [r(y)] = d \{ \{S/K\} - \{CBR - CDR + NMR\} \}$$

Although an identity, Equation 4 indicates that in order to accommodate the desired change, adjustments must be made in the socio-economic, demographic and technological components of the system. As we argued elsewhere (Sirageldin, 1991), these are not marginal adjustments. They include basic interrelated developmental transformations: demographic, mobility, human capital, agricultural, technological and institutional. An example of the interrelations between demographic and agricultural

transformations is given in Sirageldin (1993). Both transformations must act in concert. It seems rather impossible to increase significantly labor productivity in agriculture, for example, through a massive mechanization program without an equally massive spatial and occupational mobility in the short and medium terms, and a parallel decline in fertility to insure stability in the longer term. The interactive nature of migration and fertility on the stability of the socio-economic system is often overlooked. For example, it was found that rural-urban migrants are selective on low fertility. The agricultural transformation accordingly will not be as smooth (Ahmed and Sirageldine, 1993).

The developmental policy challenge is to facilitate and achieve, with minimum social and environmental costs, a sustainable completion of these transformations, by minimizing the imbalances between the two basic accumulations of human and non-human capital. Imbalances between human and non-human capital accumulation do occur, however, in the normal course of socio-economic change. Population growth may exceed or lag behind the rate of non-human capital accumulation and the growth of either accumulation may exceed environmental tolerance. The question is: under what conditions are societies able to cope with imbalances? In many instances, within institutional and technological limits, societies could cope with demographic imbalances. A celebrated mechanism is through the introduction of labor-intensive techniques in agricultural production that increase the demand for labor (see Boserup, 1965).

Beyond such limits, however, where imbalances are associated with unemployed resources or unfulfilled aspirations, demographic forces take hold through increased mortality, reduced fertility, or forced migration. These may be associated with unrest and conflict within or between countries. What are the conditions for such latter developments?

### **3.2. Population and Conflict**

What is the mechanism through which population changes create conflict? Clearly there is more than one mechanism: resource scarcity, migration, expulsion, decreased economic opportunities, or famine conditions. There are also many types of conflict: ethnic conflict, deprivation conflict, or coups d'etat. There are also various conditions that may enforce the relation between population change and conflict: inequality in access to resources or opportunities, ecosystem vulnerability, inefficient or weak governance and inefficient market functioning, among others. Indeed population is but one variable in a series of political, economic, social and environmental factors that can bring about turmoil and conflict. It is our view that the causal process that links population to conflict is contingent on the presence of these other factors. Two factors play important roles: unequal access to resources and the value imports of the modernization process in practice.

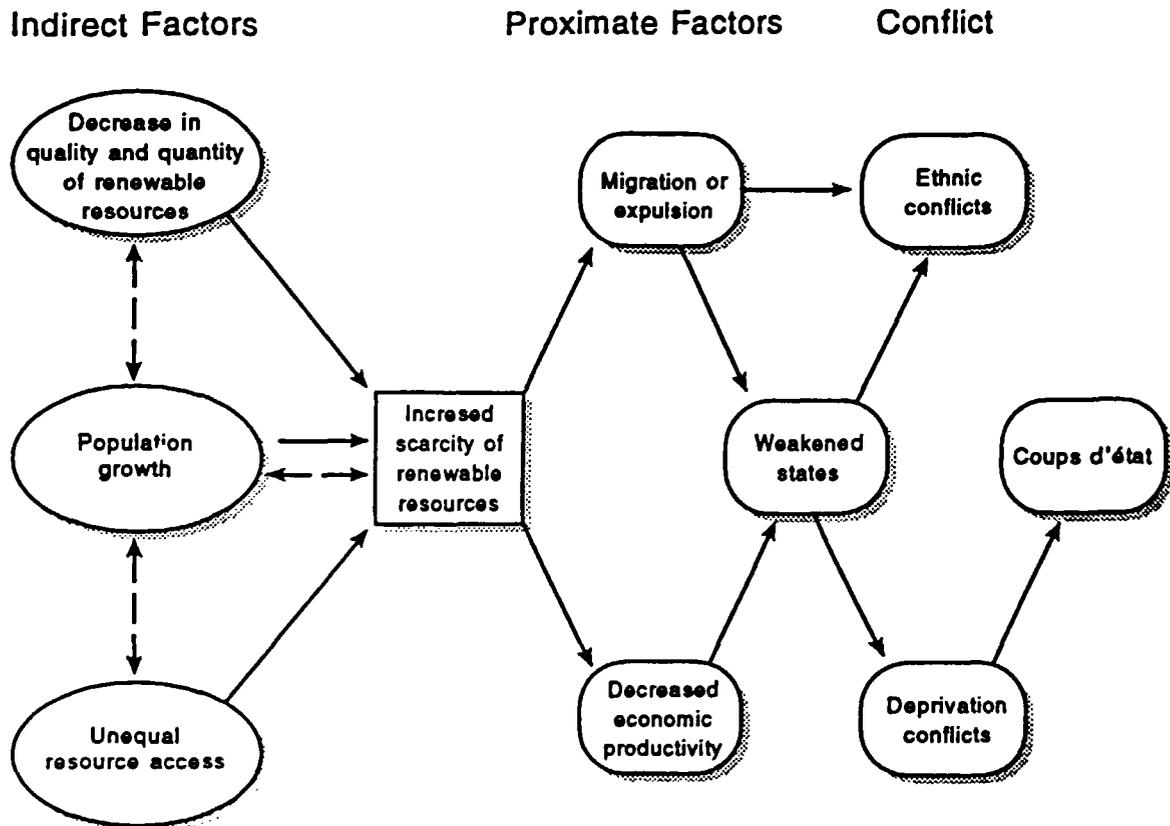


Figure 3. Some sources and consequences of renewable resource scarcity, after Homer-Dixon, Boutwell and Rathjens, 1993.

Lack of access to two basic resources, water and crop land, when combined with high rates of population growth seems to be a sure way to serious conflict. Figure 3 based on Homer-Dixon, Boutwell and Rathjens (1993) [referred to hereafter as HBR] presents a framework that links the various factors, including population, to various types of conflict.

The left-hand side of Figure 3 lists the three basic sets of factors that influence conflict indirectly through a set of proximate factors. These indirect factors include renewable resources [water and crop land], population change and unequal access to resources. The combined effects of these three sets of factors lead to increased scarcity of renewable resources. Scarcity of renewable resources increases the migration rate as well as migrants' expulsion. It also decreases economic productivity. The combined effects of these two proximate factors affect conflict directly and indirectly through their effects on the strength of the state. Migrants' displacement and productivity decline reduce the State's revenue while the State increases its spending as it deals with the deteriorating circumstances. The result is to weaken the financial and political ability of the State. The combination of forced migration, decreased productivity and a weakened State leads eventually to deprivation, ethnic conflict and finally coup d'etat.

The strength of the HBR framework lies in its simplicity, clarity and flexibility. Although lacking some important feedback linkages, it serves as a starting point for the preliminary analyses of specific case studies. Important feedback linkages that are

missing from the framework include those between environmental and population changes. These are illustrated by the dashed lines in Figure 3 [not included in the original HBR framework]. A more detailed specification of the role of population dynamics was attempted by HBR in their analysis of the case of the Philippines. This is illustrated in Figure 4. Here, the population factors play a prominent role, but continue to be exogenous to environmental and economic conditions. A fuller understanding of the role of population in this dynamic system should incorporate these feedback linkages. The cost however, is an increase in model complexity.

The simplicity of the HBR model helped to focus on the main policy issues. It tells the following story about the Philippines experience. There are lowlands and uplands. The lowland is rich, has a high population density and high rate of natural increase. The lowland is exceeding its carrying capacity and provides limited labor absorption capacity. People from the lowlands start emigrating to the uplands. However, the natural rate of population growth in the uplands is already high. The result is more cultivation of steep slopes, increased soil erosion and reduced per capita availability of productive agricultural land in upland areas. Upland welfare deteriorates. Upland populations become less receptive to immigrants. Migration streams are redirected towards urban centers. The combined effects of these dynamic forces led to conflict as follows:

1. Migration from lowland to highland created resentment in the receiving area.
2. Both types of land experienced a decline in productivity, leading to the erosion of the state's tax base.
3. As a result of reduced productivity and labor absorptive capacity in both lands, migration streams moved to urban areas. The result is increased crime rates and deteriorating health and social conditions, leading to conflict.
4. The weakened economic and political status of the state limited its ability to deal with reduced agricultural productivity and to improve deteriorating urban socioeconomic conditions.

The story is revealing and fits the Philippines setting at the time. It also leaves some puzzling questions unanswered. There is a sense of unidirectional causation that suggests an inevitable outcome insensitive to economic or demographic feedback. What is the role of public policy in this scenario, especially in the early stages of its development? To answer this question, the model needs to incorporate 'a theory of government' in order to introduce policy parameters and investigate farmers' and migrants' responses to such parameters. We know from the earlier discussion that reduced fertility today will not reduce the rate of growth of the labor force today or tomorrow. Jobs need to be created at an increasing rate to deal with the historical determinism of the age structure. However, postponement of the fertility decline will only exacerbate future consequences.

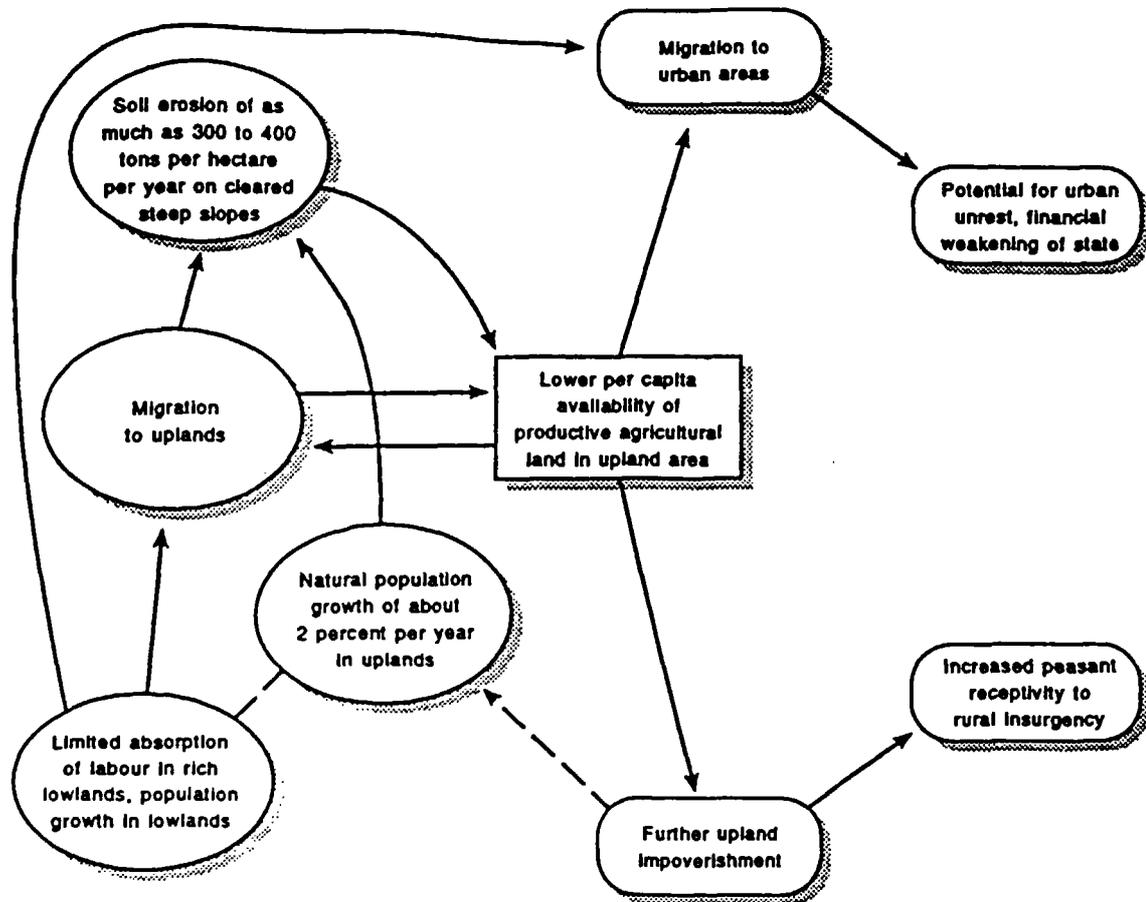


Figure 4. The role of population dynamics in the Philippines, after Homer-Dixon, Boutwell and Rathjens, 1993.

What is missing from the framework is the role of social values, ethnicity, religion and racial tensions. These are probably easier to use as control variables than to model. They also interact with economic and resource availability factors. Their net effects are hard to estimate or predict. However, they seem to be at the forefront of most of today's international conflicts. The framework is equally silent on the adaptive capacity of social institutions. How it evolves and adapts seems to be outside the framework.

### 3.3. The Role of the State

As mentioned earlier, an important characteristic of a society that succeeds in reducing overt conflict is its ability to adjust to changing circumstances and take advantage of opportunities. The role of the state in promoting such an ability has become an increasingly controversial subject in recent years. For example, what is the degree of efficiency implied in the markets of Figures 3 and 4? And what is the role of the government in that case? The figures clearly imply a strong role for the state. This role is also implied in the Robey, Rutstein and Morris (1993) discussion regarding the efficacy of family planning programs with strong public support and commitment.

The weakening of the state is taken as a result of adverse economic and social conditions and a cause of the state's inability to avert conflict. Evidently, there is a dilemma as to the appropriate size and scope of state activities, especially as an agent

of development. This dilemma was set forth with clarity by Homer-Dixon, Boutwell and Rathjens (1993:43):

"Dwindling natural resources can weaken the administrative capacity and authority of government, which may create opportunities for violent challenges to the state by political and military opponents. By contributing to rural poverty and rural-urban migration, scarcity of renewable resources expands the number of people needing assistance from the government. In response to growing city populations, states often introduce subsidies that distort prices and cause misapplication of capital, hindering economic productivity. Simultaneously, the loss of renewable resources can reduce the production of wealth, thereby constraining tax revenue. For some countries, this widening gap between demands on the state and its capabilities may aggravate popular grievances, erode the state's legitimacy and escalate competition between elite factions as they struggle to protect their prerogatives."

There seems to be a general consensus that the state should promote the conditions for an adaptive economy. But what do we mean by a flexible or an adaptive economy? This is apparently a narrower concept than our earlier definition that included both 'technical' and 'social' sustainability. The term, 'adaptive economy' has been discussed in great detail by Killick (1993:47) who states:

"Expressed in its own terms, a flexible economy is one in which ends and means are readily adjusted to changing constraints and opportunities. These include flexibility in institutional base of the socioeconomic system, as well as *flexibility on the part of the government* in adapting policy to changing conditions. It implies an economy in which movement of resources among alternative uses is relatively low friction, low cost, and rapid and leads to changing factor proportions, technologies, and composition of output... *Given the information and incentives*, the second set of conditions relates to *people's reactions to these stimuli*, that is *the responsiveness to economic signals*." [Emphasis added].

It is not our purpose to go into the relative merits of market and planned economies. Such digressions often lead to conclusions similar to that of Dr. Pangloss: All's for the best in the best of all possible worlds! Evidently, there has been an increasing tendency in professional opinion, among politicians and those they represent, to place more emphasis on market efficiency and mechanism. Most economies continue to be mixed, however. We should be able to identify the critical policy parameters. As Killick (1993:49) emphasizes: "However the balance is struck between the market and the state, we should note the importance of adequate information flows." Adequate information in this scenario improve market efficiency. An important role of the state accordingly is to improve information flows. We must be wary however, of the possibility that free information flow does not necessarily imply perfect or reliable information. Information is often used as a tool to serve political objectives even in established democracies (recall for example the use of the term "misinformation" to justify the United States' government international objectives during the cold war era and beyond). In most of the developing countries the role and size of the state are large. That does not imply good governance. Neither does it imply that the potential for good government does not exist. What seems evident is that the scope for improvements is promising.

## 4. Empirical Illustrations

In this section we examine the links between population change and two basic renewable resources, namely, water and cropland. The purpose is to elucidate the mechanisms that may trigger conflict and violence. The findings reported in the 1993 HBR study, mentioned earlier, on *Environmental Change and Violent Conflict* is an excellent base for the present discussion. Their report is based on findings from a team of 30 researchers whom they assembled to examine a set of specific cases relating environmental change to violent conflict. They focused on the two renewable resources of interest. Population was an important variable in their analyses. Their general conclusions are illustrative:

"Evidence gathered points to a disturbing conclusion: scarcities of renewable resources are already contributing to violent conflicts in many parts of the developing world. These conflicts may foreshadow a surge of similar violence in coming decades, particularly in poor countries where shortages of water, forests and, especially, fertile land, *coupled with rapidly expanding populations*, already cause hardship." [Emphasis added] (Homer-Dixon, Boutwell and Rathjens, 1993).

We start with the HBR definition of resource scarcity. Scarcity is produced in three different ways. First, it may result from degrading or consuming the resource at a rate faster than its renewal rate. Second, where the resource per capita declines as a result of a high rate of population growth. Third, where a change in the distribution of a resource results in concentrating supply in the hands of a few, subjecting the rest to extreme scarcity. We may also add, as a fourth dimension, ecological change that occurs independent of human actions.

Their first example of cropland scarcity refers understandably to the case of Bangladesh. Given the built-in population momentum, mentioned earlier, Bangladesh population of 120 millions is expected to double during the next 30 years. With an average density that is almost three times higher (2.75) than that of the neighboring Indian State of Assam, the seeds of conflict were already planted. Legal and illegal migration from Bangladesh to India have been a source of increasing conflict between the two countries and have created ethnic and religious tension and violence: "In the village of Nellie, Lalung tribespeople massacred nearly 1,700 Bengalis in one five-hour rampage" (Homer-Dixon, Boutwell and Rathjens, 1993:40). At destination, migration creates a shift in the balance of political and economic power that is violently resisted by the original power structure. It essentially creates an explosive situation that could be triggered by unexpected and often minor incidences.

This case of cropland scarcity and high rates of population growth that exceeds the effective supply of the vital renewable resource illustrates some important points related to population dynamics and conflict. The momentum of population growth that has been built through generations of high fertility does not disappear suddenly. Under conditions of increased resource scarcity, it triggers spatial movements that interact with ethnic, religious and racial origin to keep tension and violence alive through future generations. Increased density, coupled with a subsistent economy, leave little room for social or political adaptability. Environmental shocks, even minor ones, could easily trigger a chain of events that leads to forced migration and violent conflict. Almost all

areas of the world are experiencing a decline in cropland per person. The trend will continue well into the twenty-first century. This is mainly a result of the population momentum built into the populations of the developing countries. It is also a result of a very low supply response of available cropland. Asia with the highest human concentration, has the lowest per person availability of cropland, about 0.15 hectare per person in 1989 which is expected to decline to 0.1 by 2025. In Africa cropland per person was 0.3 in 1989 but is expected to decline to 0.1 by 2025. These trends in cropland availability per person, if not compensated by innovations in land use, will be a serious source of conflict through the next century.

The second case of the effects of cropland, water availability and population dynamics on conflict mentioned in the HBR study relates to the violence that erupted between Senegal and Mauritania. The violence seems to have been triggered by a complicated set of factors including a cooperative regional project: the building of the Manantali Dam on the Bafing River and the Diama salt intrusion barrage. Population growth in this part of Africa exceeds 2 percent per year. With a very young age structure, the prospect for future increase is guaranteed for many decades to come. According to an FAO report, the three countries of Mali, Mauritania and Senegal were included in the critical list of countries whose croplands cannot support current or projected populations without a large increase in fertilizer and irrigation. More intensive cultivation of existing cropland is deemed impossible without increased water resources. The situation was considered a matter of survival. Accordingly, the three countries agreed to develop these joint irrigation projects with the blessing and financial support of the international community.

The project was considered by the international development agencies a model for regional cooperation in the Sub-Saharan Region of Africa. However, the combination of the structure of political power, unequal wealth distribution and ethnic composition in these countries produced unexpected outcomes. The announcement that the Dams would be built created expectations of rising land values. In Mauritania, the elite, mainly Moors, used their power to take advantage of the situation. They succeeded in changing legislation governing land ownership in their favor effectively depriving a large segment of the population of cropland ownership. These were mainly non-Moors. Ethnic violence erupted when in 1989, some Senegalese farmers were killed in Mauritania, triggering a chain of events that led to ethnic conflict and violence in the two neighboring countries. The events included confiscation of properties, expulsions and forced migration of nationals and finally violence, which were further exacerbated by attempts on the part of the privileged groups to exploit the situation further and seize even more. The two countries were close to the brink of war.

The forces of population dynamics, especially high growth rates and uneven distribution of wealth and political power have created an increased scarcity of renewable resource endowments. The attempt to deal with the short-run implications of the situation by improving the productivity of cropland through vertical technology required action by the state that implied some difficult decisions regarding the distribution of gains and losses. These difficulties arose mainly from the presence of an unequal distribution of political power that controlled the behavior of the state, and that ran mainly along ethnic lines. On the other hand, long-term solutions that require a reduction of the excessive rates of population growth and a more efficient allocation of scarce resources for sustainable development were not forthcoming. This was the

case primarily because of the structure of existing social and political institutions. In the absence of long-run development vision and action, the potential for future conflict can only increase. It is evident, however, that the role of population dynamics in creating conflict depends on the presence of such social and political conditions. Population pressure has clearly accelerated a process that has been dormant for some time. It also reduced the system's ability to adapt effectively in the face of change.

Water is the second renewable resource that interacts with population dynamics to produce the potential for conflict and violence. The example from the Middle East mentioned in HBR, illustrates how national and international forces combine with resource scarcity and population dynamics to produce conflict and violence. The Middle East is an area where the situation of water scarcity is critical, and could only get worse in the future. The potential for political discord is significant. In the Middle East, water scarcity is combined with some of the highest rates of population growth in the world, through high rates of natural population increase or excessive net immigration. The region is also characterized by increasing cropland scarcity, unequal distribution of resource endowments, imbalances in the distribution of military power, and the presence of unstable political regimes. This is a situation where a minor incident could trigger a chain of events that would lead to unpredictable outcomes. The case of Israel and the occupied territories discussed by HBR illustrates these dynamics. Indeed concerns over access to water resources preceded the 1967 Arab-Israeli war and contributed to earlier tensions. The 1967 war, however, gave Israel control over most of the Jordan Basin's water resources. This control and the pattern of its utilization created non-sustainable imbalances between the supply and demand for water among the population groups living around the Jordan Basin that include those of Israel, Jordan, Lebanon, Palestine and Syria.

The situation is best illustrated by Miriam R. Lowi of Princeton University, quoted in Homer-Dixon, Boutwell and Rathjens (1993:44). She estimates that:

"The average amount of renewable fresh water available annually to Israel is about 1,950 million cubic meters (mcm). Sixty percent comes from ground water, the rest from the river flow, floodwater and wastewater recycling. Current Israel demand -- including that of settlements in the occupied territories and the Golan Heights -- is about 2,200 mcm. The annual deficit of about 200 mcm is met by over-pumping aquifers. As a result the water table in some parts of Israel and the West Bank has been dropping significantly. Two of the three aquifers on which Israel depends lie for the most part under the West Bank, although their water drains into Israel. Thus, nearly 40 percent of the groundwater Israel uses originates in occupied territories."

The Israeli government introduced strict measures to limit the use of water resources in the West Bank. These measures were not equitable. According to the HBR study (1993:44-45) the distribution of water resources was as follows:

"Of the 650 mcm of all forms of water annually available there, Arabs are allowed to use only 125 mcm. Israel restricts the number of wells Arabs can drill in the territory. On a per capita basis, Jewish settlers consume about four times as much water as Arabs. Arabs are not permitted to drill new wells for agricultural purposes, although Mekorot (the Israeli water company) has drilled more than 30 for settlers."

Such severe inequalities in access to such a vital renewable resource could be a serious source of conflict and violence. However, given the comparative advantage of the Israeli military power, water shortages may create more intra-country conflict than inter-country "water wars." The situation is unstable and could destabilize further through the process of population growth and its built-in momentum. For example, because of the agricultural water policy, most of the Arab Palestinian population was forced to quit agriculture. They became either unemployed or sought jobs in Israel. The Palestinian population has a very young age structure. As a result, the labor force will continue to increase at a high rate at least for half a century regardless of the path of fertility. Non-agriculture labor absorption must accommodate the natural increase in the labor force as well as the forced exodus from the agriculture sector. If not, the excess labor supply will be a source of conflict either as emigrants or unemployed civilians.

The current peace process that is being initiated in the region includes an attempt to reach agreements on water use among all parties concerned. Such agreements should reduce short-term tensions. Conflict, however, seems to be built-in the long-term high rates of population growth, their momentum and the implied increase in water demand. It must be emphasized that future demand for water does not depend only on population growth. It depends equally on improvements in living standards and on the technology used in agricultural and industrial production. These latter factors could also reduce the effective water supply by degrading water quality through increased waste and pollution. Commoner (1991) for example has found that the effect of technology on environmental degradation far exceeds that of population growth.

## 5. Concluding Remarks

In this paper, the relation between population dynamics and conflict has been examined. The conclusions reached are based on conceptual analyses and empirical observations. The main conclusion of the paper is that population change has significant effects on social and political conflict. These effects are not direct, however. They exert their impact through other proximate factors such as increased scarcity of renewable resources, reduced economic productivity, migration expulsion, or the weakening of the state authority. Furthermore, the net effect of population change on conflict is not easy to assess. The effect of population change depends on the levels of other indirect factors such as inequality and the quantity and quality of existing resources.

An important corollary is that population change could create conditions that reduce the adaptive capacity of society. That last effect depends among other things, on the structure of the social and political system. That structure includes for example, the degree of society's ethnic and cultural homogeneity and the degree of equity in the distribution of income, opportunities and political power. Furthermore, the effect of population change on the adaptive capacity of society depends on the types of political and socio-economic institutions. The probability that conflict would be reduced is greater if such institutions were able to introduce necessary changes and, in the meantime, were able themselves to adjust to accommodate such changes.

The paper identified various mechanisms through which population change affects conflict. These are long-term and short-term term effects. It was emphasized that the long-term effects of population dynamics on conflict are the most serious. This is the case because the impact of long-term trends is not sudden, it creeps in so to speak. However, once the trend takes hold through the presence of a population momentum, it becomes difficult to contain or reverse. This argument is not novel. A similar example was given by J. Goldstone (1986) where he argues that the factors that led to the English Revolution were:

"...driven by the underlying force of population growth in the preceding century and a half [which] created a synergistic stress that caused the breakdown of the state power."

The long-term effects exert themselves through the influence of the shape of the age structure on the rate of population growth and on the labor force. This built-in momentum creates conditions for system vulnerability, especially in poor countries with scarce renewable resources. It must be emphasized, however, that the built-in momentum of labor force growth is not necessarily a negative influence. It could be a source of future conflict, or alternatively, a facilitator for development. Whether society moves towards a costly conflict or towards sustainable development will depend on the success of its development efforts and how equitable its outcome. A continuation of high rates of population and labor force growth will generate conditions for violent conflict. Countries that postpone their fertility transitions will only increase the size of the momentum, increase its impact on system vulnerability and reduce the potential for sustainable development.

The short-term effects are mainly those of population movements. Population movements are initiated by the long-term interplay of population growth and resource scarcity. Large movements occur as a result of sudden shocks when society reaches a state of system vulnerability. Population movements are equally sensitive to non-demographic forces. Relative deprivation as a result of economic inequalities within countries or across neighboring countries could result in large and sometimes unwelcome population movements leading to expulsion. Conflict is more likely to occur in situations that include ethnic, religious or racial minorities, and where inequalities are high and identified with these social groups.

The remainder of this section provides a brief summary of the empirical findings.

1. In countries with extreme poverty and high cropland density, population movements may cross international boundaries. Serious conflict arises especially in the presence of ethnic rivalry. This was the case of Bangladesh and Assam. The case also represents the situation of many Sub-Saharan African countries.
2. In countries with severe economic and political inequalities, conflict could arise even as the state attempts to remedy the negative consequences of long-term population growth. Such conflict could cross international boundaries. This was the case of Mauritania and the Senegal. Population growth created resource scarcity. The elite who had political power were able to extract privileges. A process of costly ethnic violence erupted. The resolution of that short-term conflict did not deal with the basic underlying causes. There has been no serious effort to deal with the excessive rates of population growth. Neither resolved is the inequity of the political system that reduced the ability of the state to deal

efficiently and equitably with such situations. The potential for future violence is very much alive.

3. Countries with joint claims on a critical renewable resource, such as water in the Jordan Basin, impose solutions based on relative military power. In the aforementioned case, these solutions did not give adequate regard to the needs of large segments of the population. When solutions are imposed based on ethnic or religious lines, the outcome is an unstable system that serves as a breeding ground for conflict. The potential for future conflict increases when the populations concerned have a high growth momentum. The need for international mediation becomes essential. This is the Middle East case.

In our discussion of the Middle Eastern region, we only emphasized the potential role of population dynamics in creating conflict in the presence of renewable resource scarcities. We did not dwell on the role of oil politics and the associated international labor migration in the region, especially in the Gulf countries (see Sirageldin, 1992). There seems to be potential misreading of the directions of future events in the region that requires comments. The Economic and Social Commission of Western Asia [ESCWA], for example predicted that the non-national labor force in the Gulf countries will continue to grow at the rate of three percent a year through the present century (ESCWA, 1992). Such scenarios have been used to predict future economic trends in the region, including external financial flows (see Diwan, Squire and Underwood, 1993). The analyses might be valid in the immediate term. As the discussion of the present paper illustrates, 'longer-term trends and prospects' must account for the interaction of population momentum and resource scarcity on the one hand, and the ability of the social and political structure to accommodate these fundamental changes on the other hand. In a recent comparative analysis of the political economy of Egypt and Turkey during the period 1950-1985, Hansen (1991) shows convincingly that

"...development in both countries have been too complex to permit simplistic inference and conclusions about causes and effect of poverty, equity and growth".

However, Hansen finds some significant differences between the two countries that explains observed differences in the path of their agricultural development. Agriculture grew in Turkey but not in Egypt during the analysis period mainly because Turkey was able to expand the extensive margin of land until about 1960, whereas Egypt had reached this point by 1900. The importance of relating the growth momentum of the labor force to resource scarcities needs no emphasis. However, that momentum seems underutilized in the analyses of trends and consequences of migration flows in the region. To illustrate, the growth of the native labor force in Saudi Arabia and other Gulf countries is about 3.5 percent per year. Because of the built-in population momentum, this rate will continue to increase for the next forty years at least. The result is a four-fold increase in the size of the national labor force in these countries. Such a prospect should be the basis for the analysis of longer-term trends and consequences of migration flows. The potential for future conflict is already built-in the present socio-demographic system. Present analyses and policies should anticipate the consequences of such built-in demographic momentum, especially as it interacts with the resource base. Goldstone's (1986) analysis, mentioned above, is illustrative of such historical consequences.

In summary, the discussion indicates that the effect of population change on violence depends on the existing socio-economic and political structure. But the strength and ability of the state to manage also depend on that same structure. Most of the literature on conflict focuses on the short-term manifestation of population change, such as population movement. Forecasting the future, however, requires a careful look into the shape of the age structure and long-term population dynamics. Almost all of the populations of the developing world have a young age structure with a high momentum for growth especially its labor force. Disparities between the future supply and demand for labor could generate processes leading to serious conflict. National and international agencies should focus on strategies that promote efficient and equitable development, and that seriously reduce fertility. As mentioned in the context of the population dynamics basis for a sustainable agricultural transformation in Egypt:

"The problem is that in Egypt the short-term issues (crises) have taken precedence. The success of the policies adopted is a matter of survival. Indeed, all governments are concerned about balancing political stability, equity, and efficient utilization of resources. However, sustainability is an issue of intergenerational equity, and *attempting to buy political stability today at the expense of instability tomorrow is not a sustainable strategy.*" [Emphasis added, Sirageldin, 1993:228].

## Footnotes

- \* A draft of this paper was presented at the Workshop on "Environment, Resources, and Population as Sources of Conflict in 2014." Organized by the Institute for National Strategic Studies, National Defence University, Washington D.C., on July 19, 1994. Views Expressed in this paper are those of the author and are not necessarily those of the affiliated institutions. The paper benefited from the discussion in the Workshop and from comments by Carol Underwood of the Johns Hopkins University.

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## CHAPTER 11

# SPATIAL POPULATION DISTRIBUTION IN MEXICO STRATEGIC MICRO-REGIONS AND ENVIRONMENTAL PROBLEMS

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### 1. Introduction

One of the demographic challenges which faces Mexico is the distribution of population within its territory. The urbanization process which Mexico has undergone in the last decades has resulted on the one hand in a great dispersion of population in small communities and on the other hand an extraordinary concentration of population in some large cities, the most notable being the metropolitan zone of Mexico City, which is the fourth largest in the world with more than 15 million inhabitants in 1990. The economic, social and environmental costs in both cases acquire a growing magnitude. With this situation in mind, The National Council on Population (CONAPO) has carried out in-depth studies regarding the structure and function of the nation's cities and the possibilities of regional development. Based on these studies, a policy has been defined to promote a population distribution in the national territory which corresponds to the development potential of distinct regions, taking into account both national as well as international migratory movements (National Program of Population, 1989-1994).

The design of the policy, including any practice derived from it, rests on basic criteria of economic and social development within a framework which considers the availability, use and conservation of natural resources.

In this paper the way in which environmental elements have been taken into consideration during this process is presented. It is a description of the approach and the types of concepts related to population and environment which are being used only recently in the demographic planning of Mexico. Recent development and characteristics of population distribution in Mexico are analyzed; the criteria and the classification of Mexican territory by areas, according to their capacity to attract and retain population. The method of selection of micro-regions considered strategic in order to modify the existing pattern of population distribution is also presented, including a description of their principal geographic and environmental aspects.

### 2. Migratory Flows and Territorial Organization

Population distribution in Mexican territory has been closely linked with the model and politics of economic development that have been put into practice throughout its

history. Mexico became a predominately urban country with the advent of industrial development. This was reflected in a change in the rate of urbanization from 20 per cent in 1940, to 38 per cent in 1970 and 57 per cent in 1990, when of the 81 million Mexicans, 46 million lived in the 416 urban localities<sup>1</sup>

Internal migration has played an important role in shaping the distribution pattern. Rural-urban migration, which was directed principally towards Mexico City and to a lesser degree to Guadalajara and Monterrey, predominated until 1970 (Fig. 1). In the late eighties, in contrast, places of origin and destination were multiplied in the entire country; movements from city to city increased and the growth of medium-sized cities was strengthened (Fig. 2). As a consequence, even though the average density of the Mexican Republic is 41 inhabitants per km<sup>2</sup>, among the 32 states there are extreme contrasts, such as Baja California Sur with 10 per km<sup>2</sup> and the Federal District (Mexico City) with over 5,000 inhabitants per km<sup>2</sup>. In like manner, six out of every ten Mexicans reside within the central perimeter of the country (20 per cent of the surface, Fig. 3). An example of the excessive urban concentration is the fact that a quarter of all Mexicans live in one of the three largest metropolitan zones (Mexico City, Guadalajara and Monterrey) within a surface which represents barely 0.6 per cent of the national territory.

This process of urbanization has formed a national system of cities (31 sub-systems) with internal malfunctions. Existing within this system are regions which are tightly integrated, others with low levels of integration, urban-regional networks poorly defined and also excessive urban concentrations.

These maladjustments are reflected in the different levels of well-being and in varying conditions regarding environmental quality. There are areas with overuse of resources and others with underused resources.

### **3. Regional Possibilities and Demographic Distribution**

CONAPO has developed studies under the premise that the distribution of population responds to characteristics of regional development and that in order to influence the former the latter must be considered. Work has been done with this line of thought to study: a) the structure and function of urban-regional systems via their central locations and respective hinterlands and, b) the regional possibilities in order to absorb or retain population. Thus, a network of over 800 locations has been defined according to their urban hierarchy, and approximately 70 functional regions and more than 200 micro-regions have been classified according to their possibilities of regional development in areas with capacity to absorb population and to retain population (Figs. 4, 5 and 6).

Also important for the classification of micro-regions according to demographic capacity were natural resources and the possibility of their availability. In addition, other regional factors were taken into consideration such as; the system functioning, the development of the social and productive infrastructure, the economically active population and the standard of living (this did not involve a quantitative analysis).

#### 4. Strategic Micro-regions

Some micro-regions have been selected in order to encourage change in population distribution by taking advantage of development possibilities in distinct regions of the country. These are considered strategic because they fulfil the following requisites:

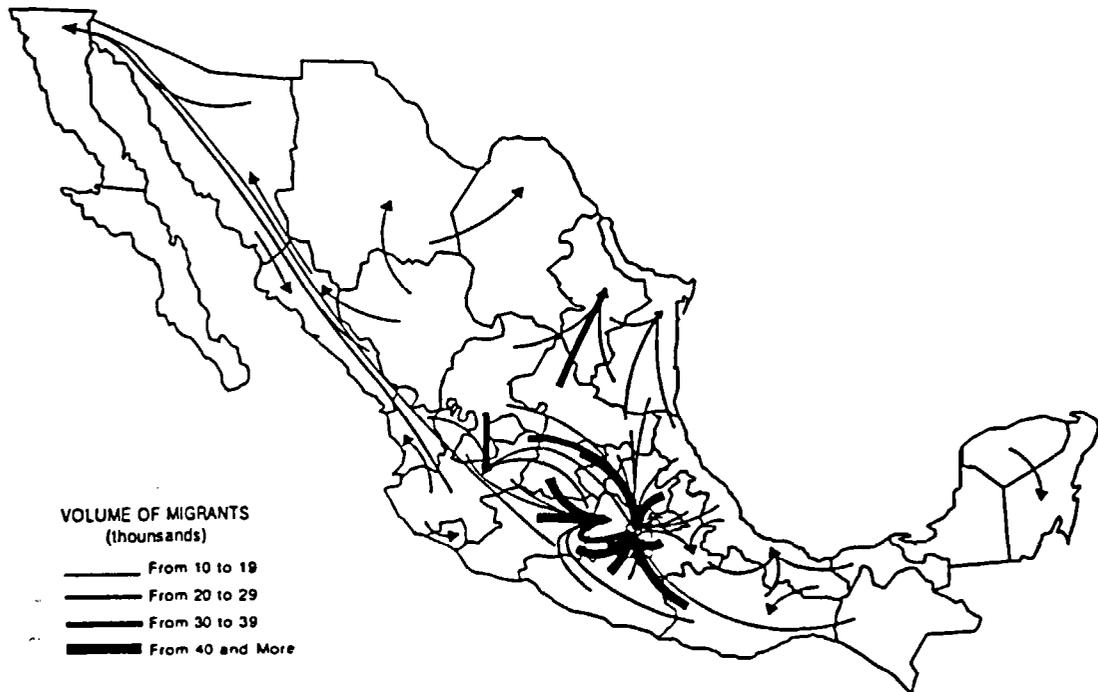


Fig. 1. Principal interstate migratory flows in Mexico 1965-70, produced by CONAPO based on INEGI. IX Censo general de población y vivienda, 1970.

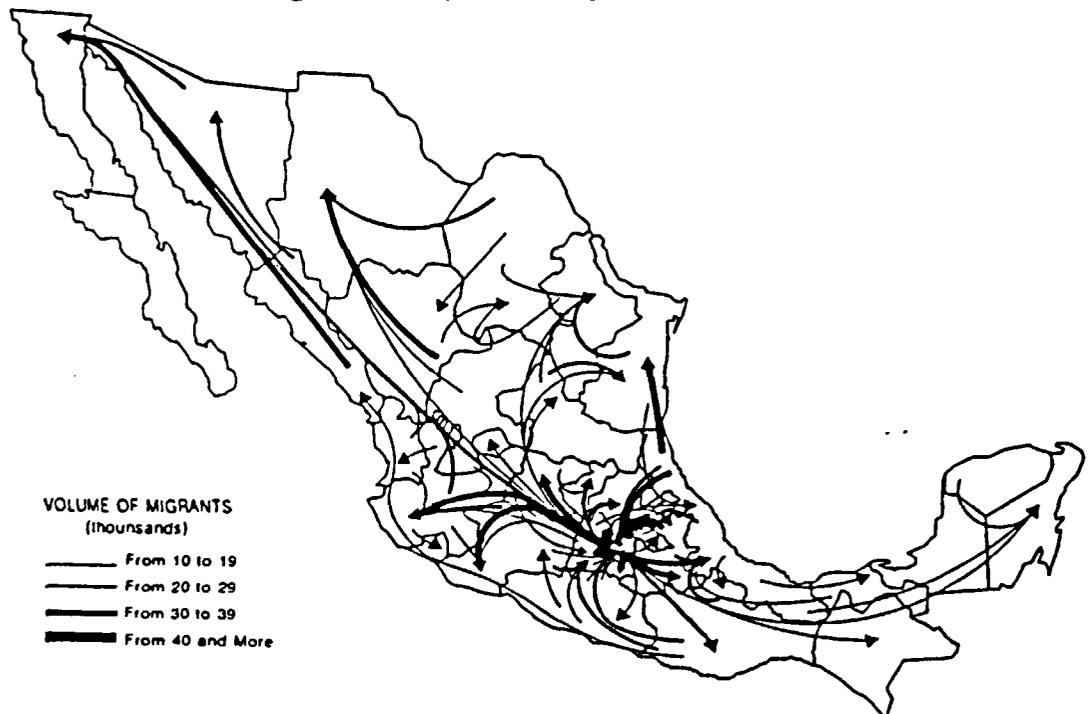


Fig. 2. Principal interstate migratory flows in Mexico 1985-1990, produced by CONAPO.

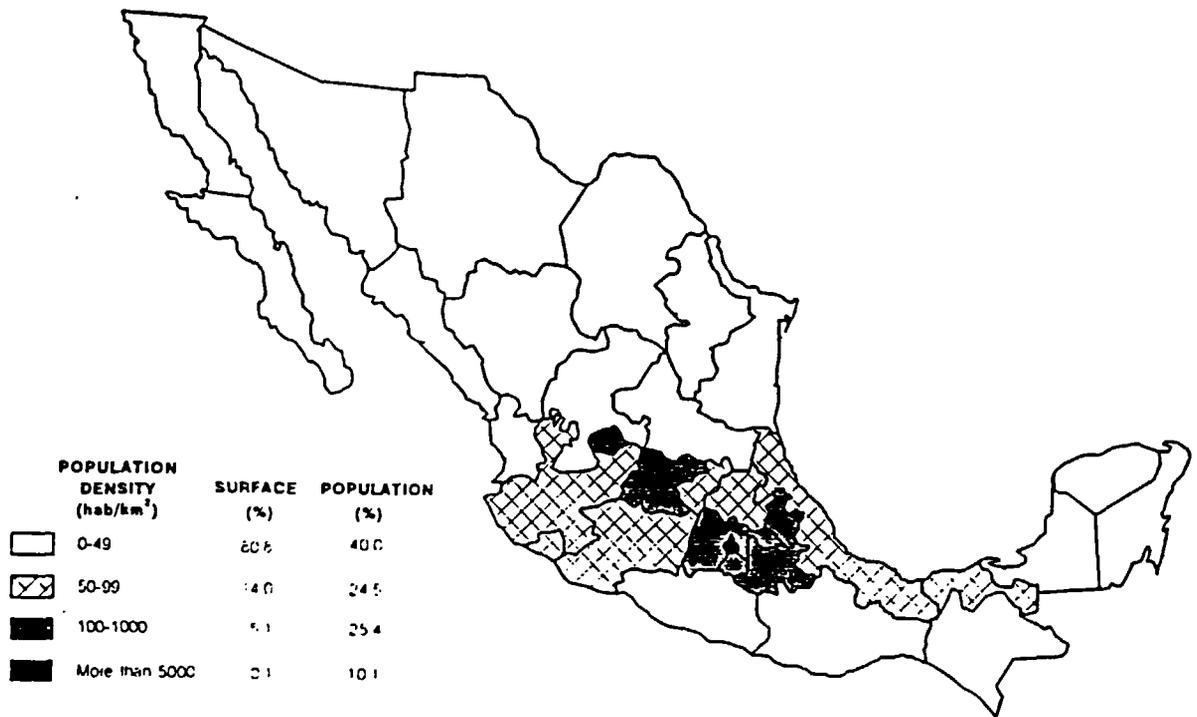


Fig. 3. Population density in Mexico, 1990. Sources: OSIC, IX Censo general de población 1970; INEGI, XI Censo general de población y vivienda 1990.

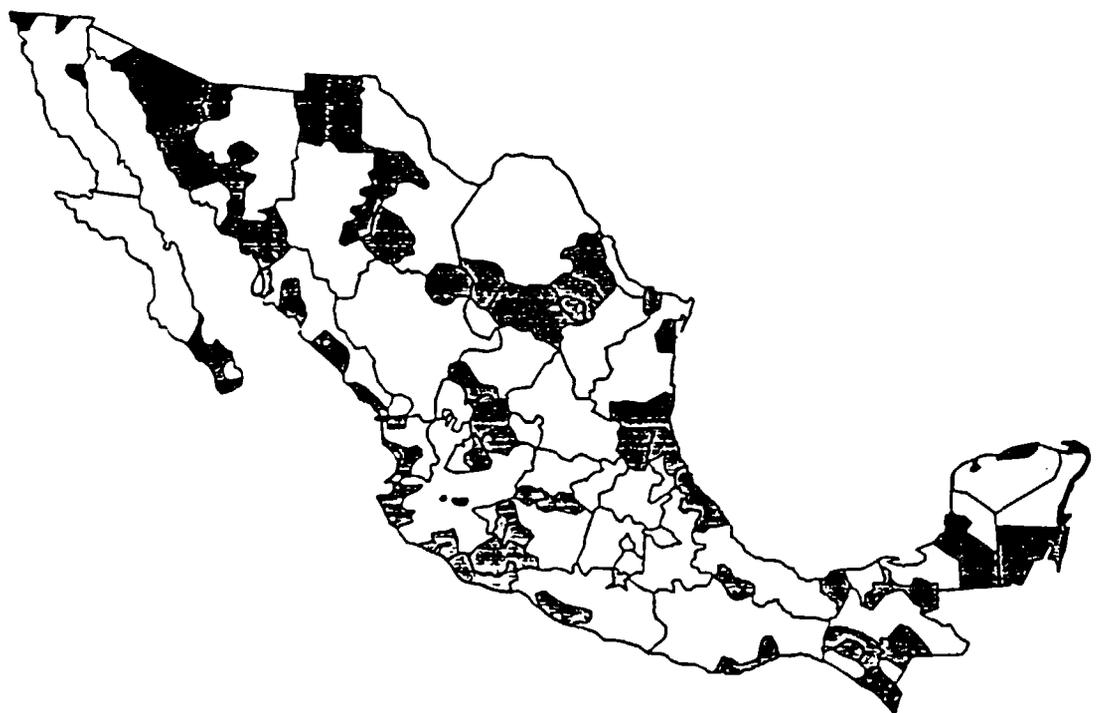


Fig. 4. Micro-regions in Mexico with capacity to absorb population. Source: CONAPO, *Sistema de Ciudades y Distribución Espacial de la Población en Mexico*. Tomo 1, Mexico, 1992.



Fig. 5. Micro-regions in Mexico with capacity to retain population. Source: CONAPO, *ibid*, 1992.

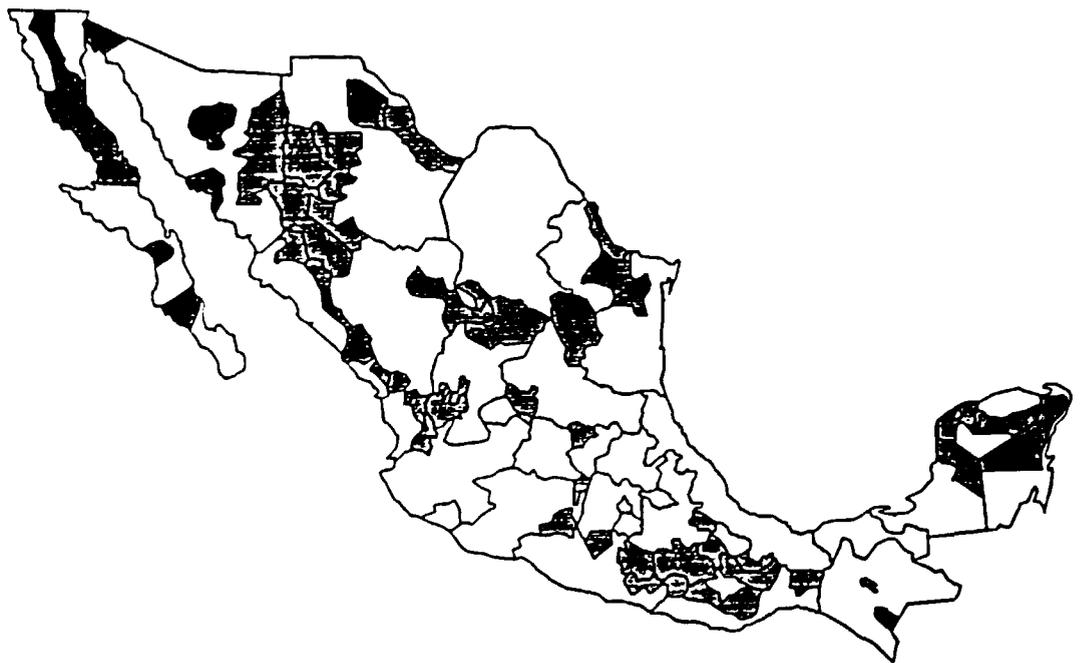


Fig. 6. Micro-regions with critical capacity to retain population. Source: CONAPO, *ibid*, 1992.

- They are the source of high density migratory flows to the large urban centers: Mexico City, Guadalajara, Monterrey, Puebla, Tijuana and Ciudad Juarez.
- They have the capacity to absorb population and also they have favorable conditions to initiate, re-activate or increase economic activities, to generate employment and to increase the standard of living of their own population.
- Their central cities are important in functional terms within the context of their respective macro-regions and a greater integration with these urban centers and areas of influence is possible and recommendable.
- In many cases these regions exhibit potential to arrest the excessive concentration of population in some macro-regions where a high percentage of total population is concentrated in the capital city.
- They are located at a considerable distance from the center of the country.
- They are outside the area of direct influence of the four principal metropolitan areas.
- They are predominately located between the northern border and the central belt of the country, or in one of the coastal regions of the Gulf of Mexico, the Pacific Ocean or the Caribbean.

With these criteria, 44 micro-regions will be selected to be developed, taking care to increase production and employment, better the quality of life and exploit rationally resources in order to preserve them for future generations. In 1990 these micro-regions contained 17.1 million inhabitants, that is 21 per cent of the total national population on 24 per cent of the territory (Fig. 7). The average density was 19 inhabitants per km<sup>2</sup> (Table 1).

Each selected micro-region has an identified potential of development that can be a combination of the following types: agriculture, cattle-raising, forestry, fishing, industry, mining, energy, tourism and artisanship. Since these micro-regions and their respective central places constitute units to attract population, and considering that their development should increase both productivity and labor intensive employment while preserving natural resources for future generations, it became necessary to conduct an analysis of their natural resources and environmental characteristics.

For this analysis, a study which presents a diagnosis concerning the environmental conditions of the different regions of the country<sup>2</sup>, dividing the territory into 88 provinces and 1,813 eco-geographic systems was reviewed. Since this analysis was based on territorial units, different from the selected micro-regions, it was necessary to situate the latter within the eco-geographic system to obtain a description of the most extreme environmental problems. The variables used to obtain a panorama of these problems were: risk of erosion, incompatibility of land use (agriculture, cattle-raising or forestry), the decrease or extinction of any variety of wildlife or plant life (terrestrial or aquatic), and pollution (air, water and/or soil) by type of pollutant (agro-chemical, industrial waste, noise, urban waste, radiation or emission of gases).

## 5. Environmental Characteristics of Selected Micro-regions

Mexico has a wide variety of geographic landscapes and eco-systems within nearly 2 million km<sup>2</sup> and more than 10 thousand km of coastal areas. The climate of 75 per cent of the nation's territory is either very arid, arid or semi-arid. Water is a scarce resource in 87 per cent of the territory and in areas where it is abundant, it is not taken advantage of due to lack of water recovery facilities (Bassol, 1987).

Within the national context there are four vast zones defined for their climatic characteristics (Fig. 8): the temperate zone, the tropical humid zone, the dry tropical zone and the arid zone (Poder Ejecutivo Federal, 1984:30).



Fig. 7. Priority macro-regions for attracting and maintaining population. Source: CONAPO, *ibid*, 1992.

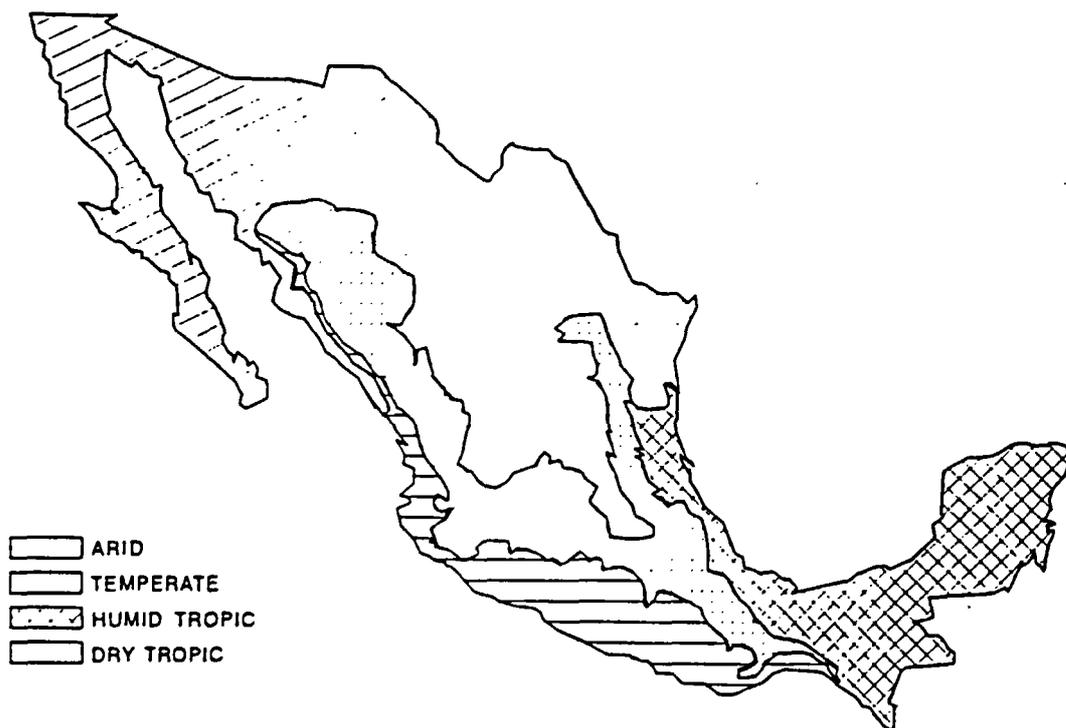


Fig. 8. Climatic zones of Mexico. Sources: CONAPO, *ibid*, 1992; Poder Ejecutivo. Federal. Programa Nacional de Ecología 1984–1988, Mexico, 1994.

TABLE 1 POPULATION, SURFACE, DENSITY, DEMOGRAPHIC CAPACITY AND DEVELOPMENT POTENTIAL OF PRIORITY AREAS

Micro-Region and Micro Region	1990	Area		DENSITY (hab/km <sup>2</sup> )	DEMOGRAPHIC CAPACITY 1/	DEVELOPMENT POTENTIAL														
		(Km <sup>2</sup> )	%			1990	Agri- culture	Fore- stry	Cattle- raising	Fishing	Industr y	Minin g	Energ etics	Hydra ulics	Touris m	Ardean- ship				
TOTAL NATIONAL	81,249,645	19,671,830	100.00	41																
TOTAL DE Macro Regionis	17,284,639	5,098,888	25.47	34																
NORTHWESTERN	2,335,227	933,092	4.74	25																
Ciudad Obregón, Son.	624,562	2,092,700	1.06	30	A															
Culiacán, Sln.	601,123	704,399	0.36	85	R															
Guaymas, Son	175,109	1,291,477	0.66	14	C															
Hemosillo, Son.	459,118	2,563,111	1.30	18	A															
La Paz, BCS	160,970	2,372,400	1.21	7	A															
Mazatlán, Sln.	314,345	3,068,500	0.16	102	A															
NORTH-CENTRAL	1,326,035	9,760,733	4.96	14																
Bocoyua, Chih.	92,921	2,284,900	1.16	4	C															
Chihuahua, Chih.	590,970	3,022,800	1.54	20	A															
Durango, Dgo.	413,835	10,041,600	0.51	41	A															
Hidalgo del Parra, Chih.	144,232	1,330,370	0.68	11	A															
Santiago Papasquiaro, Dgo.	84,077	21,185,000	1.08	4	C															
NORTHEASTERN	1,993,608	6,133,511	3.12	32																
Ciudad Victoria, Tam.	330,096	2,246,866	1.14	15	R															
Galeana, NL	112,787	1,900,120	0.97	6	C															
Tampico, Tam.	758,834	15,078,600	0.77	50	A															
Torreón-Gómez Palacio-Lerdo, Coah. y Dgo.	791,891	4,806,700	0.24	165	R															
CENTRE-NORTH AND WESTERN	3,729,761	9,804,500	4.98	38																
Ameca, Jal.	237,587	11,647,700	0.59	20	R															
Apatzingo, Mich.	345,299	13,768,100	0.70	25	A															
Aulán, Jal.	238,504	11,430,300	0.58	21	R															
Ciudad Valles, SLP	582,345	10,238,100	0.52	57	A															
Colima, Col.	428,510	5,455,000	0.26	78	A															

TABLE 1 (Cont'd.)

AREA Y AREA	SUPERFICIE		DENSITY (hab./km <sup>2</sup> )	DEMOGRAPHIC CAPACITY 1/	DEVELOPMENT POTENTIAL												
	1990	(Km <sup>2</sup> )			%	Agri- culture	Fore- stry	Cattle- raising	Fishing	Industr y	Mining	Energ etics	Hydra lics	Touris m	Artisan- ship		
Fresnillo, Zac.	244,773	9556.8	0.49	A			X		X								
Matamoros, SLP	123,595	7940.0	0.40	C	X			X									
San Luis de la Paz, Gio	137,999	2625.4	0.13	R		X			X								
Tepic, Jal.	297,834	6693.8	0.34	R				X								X	
Tepic, Nay.	268,185	2274.4	0.12	A	X			X							X		
Tejate de González Ortega, Zac.	65,236	4359.0	0.22	R	X										X		
Uruapan, Mich.	359,404	3675.5	0.19	A	X				X						X		
Zacatecas, Zac.	400,490	8381.4	0.43	A					X						X		
CENTRAL	2,035,419	28727.2	1.46	A													
Cadereyta, Oro.	85,318	3149.7	0.16	C					X							X	
Igniala, Gro.	295,763	3943.9	0.20	A		X			X						X		
Tehuacan, Pue.	1,430,015	13414.2	0.64	C	X				X						X		
Zimatlán, Gro.	224,323	8219.4	0.42	A	X				X							X	
GULF	1,902,640	20344.2	1.03	A													
Macisparrá, Tab.	166,491	3381.0	0.17	A	X				X						X		
Poza Rica, Ver.	1,243,801	11272.0	0.57	A	X				X						X		X
Villahermosa, Tab.	492,348	5691.2	0.29	R	X				X						X		
SOUTH PACIFIC	2,885,453	59643.8	3.03	A													
Juchitán, Oax.	284,831	8134.7	0.41	R	X				X						X		X
Oaxaca, Oax.	718,942	8762.4	0.45	R	X				X						X		X
Salina Cruz, Oax.	189,485	6675.1	0.34	A	X				X						X		
Tapachula, Chi.	579,367	5775.5	0.29	A	X				X						X		
Tlaxiaco, Oax.	418,194	16333.1	0.83	C	X				X						X		
Tuxtla Gutiérrez, Chi.	694,634	13963.0	0.71	A	X				X						X		X
YUCATAN PENINSULA	1,076,496	41956.5	2.13	A													
Campeche, Camp.	245,481	23130.4	10.18	A	X				X						X		X
Chetumal, Q. Roo.	172,563	17189.8	0.87	A	X				X						X		X
Merida, Yuc.	658,452	16363.3	0.08	A	X				X						X		X

## **5.1. Temperate Zone**

The temperate zone covers nearly 19 per cent of the national territory. It is characterized by high mountainous terrain plus it has supported most of the urban, industrial and demographic growth because it comprises the principal economic and production activities of the nation. Located in this ecological zone are some of the main cities such as Mexico City, Puebla, Toluca and Guadalajara. The activities that are carried out in these urban centers and others of lesser size, generate pollution in their surroundings to varying degrees: among the most notable is the contamination generated by the discharges of sewage and industries in the river-basins Lerma-Santiago, Panuco and Balsas, as well as the diverse problems associated with the socio-economic dynamics of the nation's capital city.

There are 19 priority micro-regions in this zone. They are located mainly near the coasts of the Pacific Ocean and the Gulf of Mexico. Portions of their territories have climates which are arid, dry tropical and tropical humid. In parts of these micro-regions pertaining to the temperate zone, the risk of erosion predominates and in many cases the decrease and extinction of wildlife is relevant. To take advantage of their resources (notably agriculture, cattle-raising and industry) without harming soil productivity, it is necessary to apply techniques that help their conservation and permit an increase in their yield (Table 2).

Micro-regions having major regional cities present problems of extreme pollution in air, water and soil due to industrial activities and services. Four of the ten micro-regions manifest extreme environmental problems in seven or eight of the variables analyzed, because they are located in very fragile ecosystems which are seriously affected by industries in general and oil-related industries in particular.

Regarding demographic capacity, five micro-regions show critical conditions to retain their population. This provokes high migratory flows, principally towards the large urban centers. In like manner, eight other micro-regions have the capacity to attract population and the six remaining, have the capacity to retain population.

## **5.2. Tropical Humid Zone**

The tropical humid zone covers flat regions with altitudes of less than 100 meters above sea level. It encompasses more than 17 per cent of the national territory and extends over the coastal plain of the Gulf of Mexico and the Yucatan Peninsula. The ecosystems of this zone are very fragile and have been altered by different means. Located within this zone are 11 micro-regions, seven with complete territories and four others with most but not all of their area within this climatic zone.

The basic problem in these micro-regions is the risk of erosion, the decrease and extinction of wildlife and plant life, both aquatic and terrestrial, as well as the pollution of the air, water and soil. Among the principal causes of this situation are cattle-raising activities which have been dynamic but have provoked the destruction of forests and jungles in order to plant for pasture ground. Another

relevant factor is the oil industry which has caused drastic changes in the traditional patterns of the use and quality of the soil, thus harming other production activities.

The most outstanding potential of these micro-regions is related to fishing, industry, water resources and tourism. Nine micro-regions show capacity to attract population, one to retain population and another one has critical capacity to retain population (plus being one of the regions which presents the greatest number of severe environmental problems).

In four micro-regions the problems are serious in regard to more than six of the environmental variables, and in three other micro-regions there is an extreme problem in at least five variables. This means that more studies should be undertaken which permit the formulation of specific recommendations to achieve a better yield from resources and the restoration and conservation of these within each micro-region.

### **5.3. Dry Tropic Zone**

The dry tropic zone comprises about 13 per cent of the national territory. It extends along the Pacific Coast, south of the Tropic of Cancer and continues towards the center of the country. Above all, this area presents problems of water and soil pollution as well as erosion and underuse of resources. The agricultural development is slow because of topographical problems and scarce rainfall. Cattle-raising is extensive but of low yield, thus contributing to a greater deterioration of the soil and natural vegetation.

Twelve micro-regions are located in this zone, six of them with their total surface area and the other six with portions in other climatic zones. The environmental problem in these micro-regions is less serious than others located in different zones. This is due to the fact that the ecosystems are not as fragile as those of the humid tropics and in general have not been exploited as severely as in the temperate zone.

These micro-regions have all types of potential. Although agriculture, cattle-raising and industry are the most prevalent, they also have hydraulic and energy resources which are essential to their development.

The most notable problem is the risk of erosion and the pollution of water due to the use of agrochemicals and urban and industrial wastes. The micro-region of Juchitan, in particular presents an extreme environmental problem in the most number of variables studied as a result of industrial and oil-related activities which are found in the south-eastern part of the country. This problem is a determining factor in the formulation of programs to foster development in these micro-regions especially if these programs intend to fulfil the objective of attracting and retaining population as well as to raise the standard of living.

The dry tropic zone has a vast extension of coastal areas along the Pacific Ocean. nevertheless, this resource has been poorly exploited and, on the other hand, there are fishing methods which affect the existence of some species.

## **5.4. Arid Zone**

The most extensive climatic region is the arid zone with approximately 52 per cent of the national territory. Here the predominant activities are cattle-raising, agriculture and the exploitation of indigenous floral resources. The specialization in the field of production has resulted in the over-exploitation of land and some plant species. The consequence of this is erosion, desertification, underuse of existing resources, both water and soil pollution due to indiscriminate use of agro-chemicals, exhaustion of the natural water supply and also the salinization and substantial alteration of its ecosystems.

On the other hand, this zone has vast mineral resources, and also resources which could be developed to produce alternative energy sources such as solar energy. This potential has been under-exploited which contrasts with the excessive concentration of population in a few urban-industrial centers which lack these types of resources.

Of the total number of micro-regions selected to apply the policy of population distribution, the ones in this zone present less serious environmental problems. A total of 22 priority micro-regions are to be found in this area. Nine have their total surface area in this zone while the other 13 have less than their total area. Thirteen of them present extreme problems in less than four of the ten environmental variables analyzed, and only one (Tampico) has problems in eight variables. The risk of erosion and the decrease and extinction of wildlife are the predominant occurrences. In contrast, these micro-regions possess a vast potential in the fields of agriculture, cattle-raising and industry. The methods which have been used for production activities harmed land productivity and generated pollution in the region's water-basins. Therefore, it is necessary to re-think forms of resource exploitation in order to preserve them.

Eleven of the selected micro-regions have critical capacity to retain their population. Although the arid zone does not compare with the rich natural resources of other zones, it does have other types of advantages and less depletion of its scarce resources. Because of this, there exist alternatives for the promotion of the selected micro-regions, thus obtaining a more balanced population distribution particularly in the northern part of the country.

## **6. Continuing Work**

Until now, to modify maladjustments in the population distribution, parts of the territory have been selected which, if developed with certain criteria, would be appropriate sites to receive migratory flows. Their development potential has been identified along with their extreme environmental problems. To continue with this work a detailed analysis concerning the level of compatibility between environmental characteristics and the activities of different sectors is necessary. Also, specific recommendations are needed for the development of each micro-region and for environmental protection and ecological balance: and studies

will have to be made in order to estimate both the desired increase in population of each strategic micro-region and the number of jobs required.

In this project, the complex study of the relationship between population and environment is achieved through the use of natural resources to modify the population distribution. Although population growth alone does not generate environmental imbalance, it is important to recognize that forms of consumption, cultural patterns, technology and forms of production combined with the economic conditions of the country, provoke alterations in the environment. The excessive concentration of population in the central part of the country and in a few urban centers has contributed to the over-exploitation of resources in some areas and the under-exploitation in others. Under these circumstances, it is essential to establish policies of control to diminish environmental pollution; ecological restoration is urgent in areas of deterioration, and it is necessary to apply techniques that permit the conservation, use and enrichment of natural resources.

The challenges concerning environment are enormous. For example, Mexico is one of the most bio-diverse countries in the world. The estimated number of species it has ranges from 250,000 to 10 million<sup>3</sup>. In spite of this, Mexico has only approximately 400 specialists in this field which makes the task of enhancing knowledge even more difficult to achieve.

Nevertheless, with the aim to preserve the most fragile and most diverse ecosystems 4 per cent the national territory has been safeguarded through establishing protected natural areas. The policy of population distribution maintains the position that the preservation and the use of natural resources, in man's benefit, should go hand-in hand.

TABLE 2 MEXICO: EXTREME ENVIRONMENTAL PROBLEMS IN PRIORITY MICRO-REGIONS FOR THE POLICY OF SPACTIAL DISTRIBUTION OF POPULATION (FREQUENCY OF OBSERVATIONS 1)

MICRO- REGION	CLIMATIC ZONE 2/	RISK OF EROSION	INCOMPATIBILITY OF SOIL USE			DECREASE AND EXTINCTION OF WILDLIFE AND PLANT LIFE				POLLUTION 3/			
			AGRICULTURE	CATTLE- RAISING	FORESTRY	AQUATIC ANIMAL AND PLANT LIFE	WILDLIFE	PLANT LIFE	AIR	WATER	SOIL		
SALINA CRUZ	DT-HT												
JUCHITAN	DT	X	X	X		X (2)			X			b	
AUTLAN	DT-T	X (3)				X						a	
AMECA	DT-T	X	X	X									
APATZINGAN	DT	X (3)											
COLIMA	DT	X (3)	X	X		X (2)						a, b	
URUAPAN	DT-T	X											
TEPIC	DT-A												
CULIACAN	A-T		X	X					X (2)			a (2), d (2)	
MAZATLAN	T-A									X			
TLAXIACO	DT	X (8)	X	X					X	X		d	
CIUDAD OBREGON	A-T	X (6)							X				
IGUALA	DT	X											
ZIHUATANEJO	DT					X (2)						a (3)	
OAXACA	DT-T	X (4)	X	X								a, b, d	
TEHUACAN	T-DT-HT	X (3)				X			X (2)	X (2)	b	f	d
SAN LUIS DE LA PAZ	T-A												
TEPATITLAN	T-A	X											
DURANGO	T-A	X (7)	X (3)						X	X			
SANTIAGO PAPAQUIARO	T-A	X (2)	X						X	X			
BOCOYNA	T-A	X							X (2)		a		a
MERIDA	HT	X							X (2)	X (2)	b (2)		f, d
CHETUMAL	HT	X (5)				X			X (15)	X (14)			
SALINA CRUZ	DT-HT												
JUCHITAN	DT	X	X	X		X (2)						b	
AUTLAN	DT-T	X (2)					X					a	
AMECA	DT-T	X	X	X									

CHART 2 (Cont'd)

MICRO- REGION	CLIMATIC ZONE 2/	RISK OF		INCOMPATIBILITY OF SOIL USE			DECREASE AND EXTINCTION OF WILDLIFE AND PLANT LIFE				POLLUTION 3/			
		EROSION	AGRICULTURE	CATTLE- RAISING	FORESTRY	AQUATIC ANIMAL AND PLANT LIFE	WILDLIFE	PLANT LIFE	AIR	WATER	SOIL			
APATZINGAN	DT	X (3)												
COLIMA	DT	X (3)	X	X		X (2)							a, b	
URUAPAN	DT-T	X												
TEPIC	DT-A													
CULIACAN	A-T		X	X	X			X (2)					a (2), d (2)	
MAZATLAN	T-A													
TLAXIACO	DT	X (8)	X	X	X			X					d	
CIUDAD OREGON	A-T	X (6)						X						
IGUALA	DT	X												
ZIHUATANEJO	DT					X (2)							a (3)	
OAXACA	DT-T	X (4)	X	X									a, b, d	
TEHUACAN	T-DT-HT	X (3)				X			X (2)	(2)			f	d
SAN LUIS DE LA PAZ	T-A													
TEPATITLAN	T-A	X												
DURANGO	T-A	X (7)	X (3)						X					
SANTIAGO PAPANQUIARO	T-A	X (2)	X						X					
BOCOYNA	T-A	X							X (2)				a	
MERIDA	HT	X							X (2)	(2)			b (2)	f, d
CHETUMAL	HT	X (5)				X			X (15)	(14)			f	

1. Frequency of observations of each variable according to the related ecosystems.

2. Climatic Zones: Dry tropic (DT), Humid tropic (HT), Temperate (T), Arid (A)

3. Type of pollutant: agrochemical (a), industrial waste (b), Noise (c), Urban waste (d), Radiation (e), Emission of gases (f)

SOURCE: Secretaría de Desarrollo Social. Proyecto de Ordenamiento Ecológico General del Territorio del País, México, 1992.

## Footnotes

<sup>1</sup>The definition for urban and rural population varies according to the criteria adopted in each country and for each author. In this work, urban population exists in an area with more than 15 thousand inhabitants; mixed population of between 5,000 and 14,999 inhabitants; and rural in areas of less than 5,000 inhabitants.

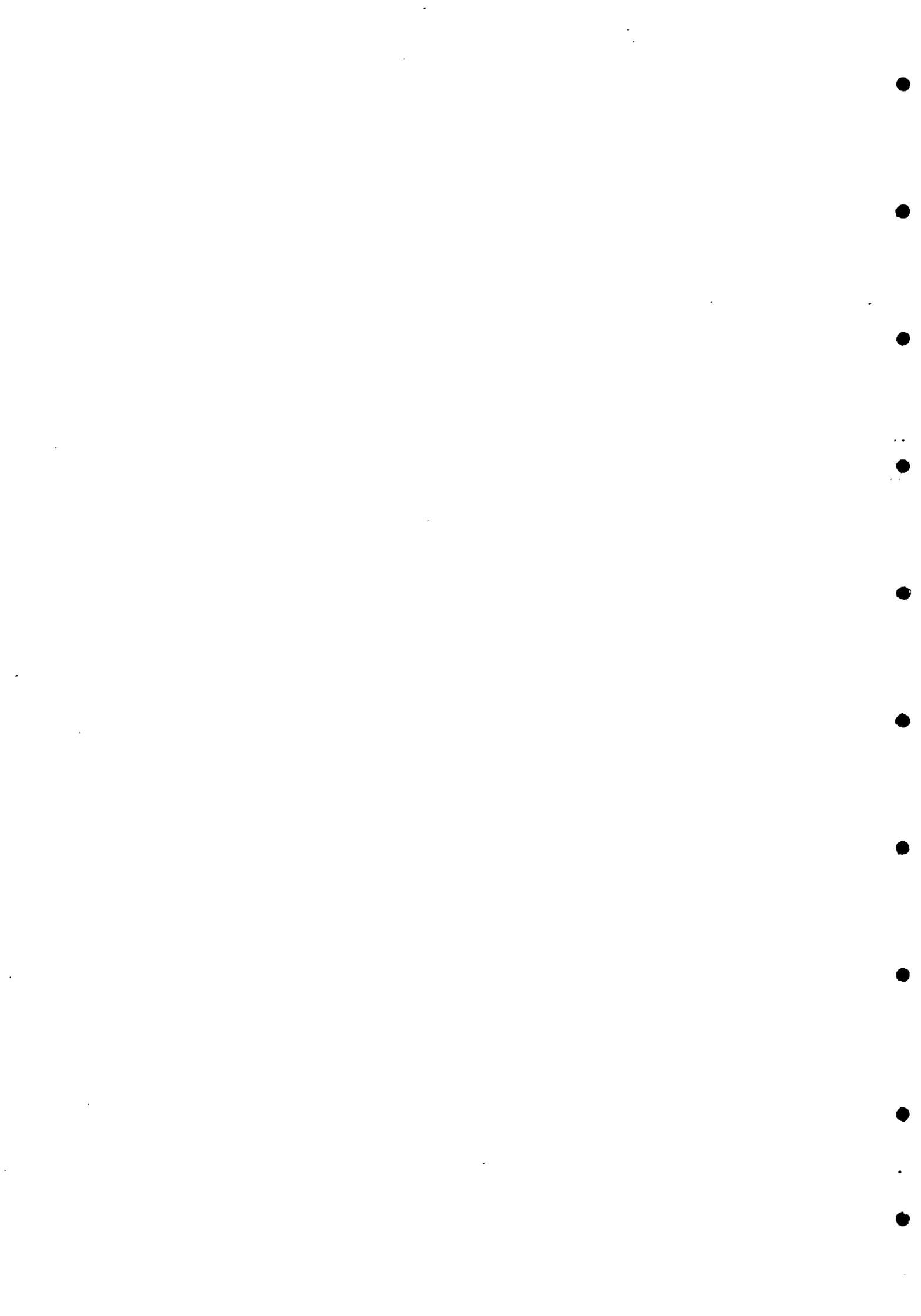
<sup>2</sup>Secretaría de Desarrollo Social. Proyecto de Ordenamiento Ecológico General del Territorio del País, México, 1992.

<sup>3</sup>Data was included among those distributed by the regional office of Latin America and the Caribbean Program of the United Nations for the Environment. Obtained in: Fernando Tudela, "Población y sustentabilidad del desarrollo: los desafíos de la complejidad". Revista de Comercio Exterior, Vol. 43, Nr 8, August, 1993. Pg. 698

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## CHAPTER 12

# POPULATION AND ENVIRONMENT IN BRAZIL: A CHANGING AGENDA

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### 1. Introduction

The decade of the nineties has brought a new – and different – urgency to the population–environment question in Brazil. Lining up solidly with Third World positions in the seventies and eighties, both governmental and academic voices expressed their resistance to identifying demographic growth rates or environmental degradation as major obstacles to development. These were consequences – not causes or obstacles – of underdevelopment, whose roots were to be found in unequal economic relations between Brazil and the developed world. In Stockholm in 1972, Brazil's delegate to the United Nations Conference on the Human Environment declared that smoking chimneys were a mark of progress and that environmentalism was a luxury only developed countries could afford. In 1974, in Bucharest, at the World Population Conference, "development was the best contraceptive." In contrast, the head of the Brazilian delegation to the Third Session of the Preparatory Committee for the International Conference on Population and Development (Cairo 94), declared that:

"Family planning is not a panacea to achieve social development, environmental balance and economic growth. It is only one of the means, *albeit a most important one*, to break the intergenerational transmission of poverty, particularly when combined with the appropriate social development policies....It is impossible to believe that a 16 year–old girl's pregnancy is genuinely wanted. A standing objective should be the avoidance of all pregnancies before the age of 19. ...Rapid steps should be taken to decrease unwanted child bearing and to guarantee universal access to reproductive health services" (my emphasis).

Today, none of the major actors who resisted family planning programs – the military, the Catholic Church, the political left – has remained immune to changing social conditions and the evolution of values and behavior. The environment, on the other hand, has moved from a non–question to a guaranteed place on the agenda of public opinion. The same declaration cited above states that "Sustainable development is central to any viable strategy directed towards improving quality of life and combating poverty. Population levels, consumption patterns and production systems are directly linked to environmental quality." These shifts in social thought

represent fundamental transformations in Brazilian life and demand attention as the nation seeks to define – and redefine – itself in preparation for the 21st century.

The present notes seek to outline the evolution which has taken place. Why did issues considered part of a modern, progressive agenda first meet such widespread resistance in Brazil? How and why did this position evolve? How did these processes shape population programs and environment programs, separately, and how were perspectives on population–environment relations affected? These are not simple questions and their answers will require a more in-depth analysis than these pages will allow. But it is possible to identify the principal issues and to raise the question more clearly. We are indeed at a watershed in Brazilian views on these questions. As we move forward to deal more directly with them, and as interested observers seek to accompany these changes, it will be useful to set out the central themes involved.

## **2. Population, Environment and Development: from the Seventies to the Nineties**

Brazil's post World War II drive for development, which reached its apogee in the late sixties and early seventies – the years of the "Economic Miracle" – left little room for environmental concerns. In 1972, at the United Nations Conference on The Human Environment, the Brazilian delegation swam against the stream of the awakening environmental consciousness. The Conference, together with the publication of the Club of Rome's *Limits to Growth* in the same year, was a watershed in linking Third World economic development with concerns for the natural resource base. But these concerns did not strike responsive chords in Brazil. Official positions, as noted above, discounted such calls for action, holding fast to developmental perspectives and a defense of more equitable trade relations.

Academic and scientific opinion did not differ greatly from this official position – especially in the social sciences. Progressive voices of the universities in these years were directed at reestablishing democracy (a 1964 coup d'état inaugurated two decades of military rule), and this priority was seen as a necessary condition for economic development with social justice. To many, environmental concerns were an epiphenomenon of more fundamental problems and a passing middle class fad of developed countries.

Similar attitudes marked academic views on population. These were the years of Brazil's most rapid population growth and the country's size made it an obvious target for international concern. While rates were to start declining in the mid-sixties, this was not clear at the time, nor even in 1972 when the Stockholm Conference was the stage for a re-enactment of the Malthusian/anti-Malthusian debate. The fact that rapid demographic growth produced international calls for birth control; that rapid economic growth benefited only a small minority of the population (leaving room for achieving greater social justice without curtailing population growth); and that the military dictatorship greatly constrained debate on all such issues, meant that fertility reduction was seen as an unacceptable alternative to reducing social inequalities and not as a component of such a process.

Both population and environmental concerns were subordinate to this ideological debate on the model of development. When developed country birth controllers later adopted environmentalism as a more fashionable and acceptable argument, more dispassionate consideration of the question in Brazil was further delayed. Today's total fertility rate of approximately 2.5, achieved without any national family planning program behind the fertility decline, has taken much of the steam out of the debate, and both issues – taken together or separately – are discussed in a less-charged atmosphere.

At the level of Brazilian experience, then, accelerated economic growth of the fifties and sixties in parallel with accelerated population growth, and rapid fertility decline in the seventies and eighties with no explicit government policy, took the wind out of the sails of older debates. Neither the diagnosis nor the prescription of neomalthusianists were sustained by recent Brazilian history.

This climate has been reflected in preparations for the 1994 International Conference on Population and Development in Cairo. Brazilian demographers have been active in this process, individually as consultants to the Foreign Ministry and institutionally through their professional association (Associação Brasileira de Estudos Populacionais – ABEP). Preparatory seminars, a population video and formal participation in the national delegation have been marked by non-confrontational dialog. While fallout from older clashes between progressives and birth controllers is still visible when representatives meet, action proposals are no longer so far apart. At the Mexico City Regional Conference in 1993, for example, the summary document was baptized "A Latin American Consensus on Population and Development." While not always all that consensual, the meeting reflected the convergence of positions on the necessity and the forms for guaranteeing access to contraceptive methods (through integrated health programs), on the urgency of urban problems relative to health and population distribution, and on the context of sustainable development in which these questions will have to be treated. This consensus does not yet include such questions as the locus of fertility regulation (the woman – or man – as an individual *versus* the family), abortion and adolescent sexuality. It is important to note, however, that the "progressive" and "anti-progressive" line-up is no longer automatic nor predictable.

In international fora, for example, many developed countries defend positions closer to Brazilian feminist causes, while more conservative views are expressed by other developing (especially Islamic) countries. In this new context, yesterday's imperialists are frequently today's allies in advocating proper attention to what has been recast as "women's reproductive health." The idea that contraception should be dealt with in the context of comprehensive health care – a cause long espoused by Brazilian and other developing country progressives – has been absorbed by such international agencies as the UNFPA. While not yet a reality in Brazil, public discussion of such programs reveals a growing consensus. That this new situation is not yet taken as a political victory by advocates of integrated health care is revealed in the lingering hostility between family planners and much of the demographic establishment.

This state of affairs is the inheritance of a prolonged period in Latin America, when family planning (and this was nearly synonymous with *population*) was seen as an

imperialist plot to diminish the number of consumers instead of increasing the size of the pie and redistributing this pie. Population control was seen as an alternative and not a component of development broadly conceived. Indeed, this was to be the case in many instances: family planning activities were often promoted as less expensive and more viable alternatives compared to providing education, sanitation and health to a growing population, and to tackling the thorny problems of land and income distribution. Considerations on individual rights and personal welfare took second place to economic strategies for development with social justice.

One issue never properly dealt with in Brazil was the stance of developed countries' progressives on population. The benefits of fertility control were taken for granted by such voices, without denying (indeed, frequently calling attention to) the basic social inequalities between developed and underdeveloped countries and within developing countries. The need to redress these inequalities as the basis for development was not an idea exclusive to poor countries. But developed country academics were seen as naïve interpreters of dominant ideologies. Their analyses did not overcome the limits of the ideological context of their work, and calls for population planning were proof of this.

### 3. Environmentalism and the Changing Academic Climate

In this context, the environmental question is one of the new issues which proposes to redefine development and redefine, therefore, the role of population in development. Most especially, it contributes to defusing the Marx/Malthus debate. It is not questioned any longer that population growth will slow and eventually cease. The question of how population growth fuels or inhibits economic growth is not, in this light, any longer the central question. The environmental debate places the absolute limits of resources (in spite of technology's role in redefining, replacing or extending supplies of resources), the quality of life and considerations on future generations on a more complex agenda.

The emergence of the environmental question at the international level occurred in parallel with the evolution of this thinking. Identified today as dramatic consequences of rapid demographic growth in developing countries, degradation and scarcity of natural resources would be first manifested, however, in countries of slow demographic growth. Critical episodes of thermal inversion in Donora, Pennsylvania in 1948 and in London in 1952 (when 2,000 people died) inspired clean air laws in the United States and England in the sixties. The poisoning of Minamata Bay, in Japan, by mercury, came to world attention in 1956 and contributed to more rigid control of industrial waste. The *silent spring* arrived first to the Northeastern United States and the alarm raised by biologist Rachel Carson, in 1962, concerning the effects of DDT on the fauna of the region were precursors of other alarms which would feed the environmental movement in that country. And in the seventies and eighties, more important than scenes of starvation in Biafra or the drought in the Sahel in sustaining the new environmental consciousness, were the toxic cloud of dioxin over Seveso, Italy, in 1977; the consequences of toxic wastes in Love Canal, in the United States in the same year; and the explosion of the nuclear installation of Chernobyl in 1986. These consequences of the industrial

way of life of rich countries inspired the first manifestations of contemporary environmental awareness.

The extension of the environmental question to poor countries in the form of a concern with rapid population growth appeared first among the neomalthusianists, who soon placed environmentalism at the service of their cause. Once the environmental question managed to sensitize public opinion, it became a good candidate for the list of arguments in favor of population control. In Brazil, as in a large part of the Third World, this initial way of linking population and environment did not resonate well in academic or governmental circles and after a flutter of criticism the issue was generally ignored.

As the seriousness of environmental limits came to be better understood, however, their relations with demographic dynamics again became the object of attention, this time from a different perspective. Considering the size of the Brazilian territory and the present stage of the demographic transition, this new attention arises not in terms of the volume or rate of population growth, but directed to questions of population distribution. The relations between environmental change and other components of demographic dynamics (fertility and morbidity/mortality) are identified as important, but not yet the object of intensive research. This change of emphasis occurred in parallel with the above-mentioned change in thinking on population and development, at the international level. Not all segments of the "population community" have absorbed this evolution, however, and today the simpler version survives in statements of birth controllers and environmentalists. Each uses the relationship in its own way and to its own ends, without having probed the possible mechanisms involved.

What we have seen in the course of these decades, then, is that the idea of the pressure of numbers on resources at first grew and later diminished among population specialists at the international level; set down roots among the neomalthusianists; and was appropriated acritically by environmentalists. Many studies and the concrete experience of developing countries serve to transform the issue of "population growth as the major obstacle to development" to "rapid growth as one factor among others which makes development *more difficult*." This difference of emphasis is accompanied by efforts to determine the mechanisms by which growth affects development.<sup>1</sup> The attenuation of earlier dichotomized positions suggests to Sawyer that the International Conference on Population and Development "may recognize explicitly that the natural environment places limits on population growth, which affects the capacity of nature to offer sustainable conditions of production and of life" (Sawyer, 1993). That this position may be put forward in Brazil without raising earlier polemics points to the new phase in which these relations are discussed.

#### 4. Environmentalism and the Brazilian Political Agenda

Brazilian social sciences, then, were slow to distinguish ephemeral and superficial expressions of environmental awareness in the United States and Europe from real threats facing man's future on the planet. An appreciation of the *social content* of environmental problems was even slower to develop. That it was the poor who pay

the price of environmental degradation and resource scarcity is only today becoming clear within the social sciences.

Two specific events, and the international attention they received, have been especially important in changing this picture. The first was the disastrous pollution of Cubatão, a steel and petrochemical complex on the coast of São Paulo. The early eighties witnessed a constant stream of denunciations of anencephaly and other birth defects, benzene poisoning and respiratory illnesses among the local population; of the slow death of the mangrove swamps which were reproductive reservoirs of innumerable ocean species of fish and crustaceans; of open dumping of toxic waste from the petrochemical and fertilizer industries which were offshoots of the oil refinery; and of deforestation of coastal slopes which resulted from acid and basic rain, with the consequent threat of landslides. Cubatão's industrial park was baptized the "Valley of Death" and the international media – from NBC and *Le Monde* to the *Village Voice* publicized the problem.

This situation galvanized public and scientific opinion in Brazil. The Brazilian Association for the Advancement of Science (SBPC), for example, was instrumental in calling attention to Cubatão. At its annual meeting in 1982, whose theme recalled the Stockholm conference ten years earlier, the SBPC created an interdisciplinary working group whose subsequent research was to have considerable impact on moving state and national authorities to action. The slow redemocratization occurring at this time both permitted this mobilization which finally led to government action and widened the political arena to include other issues than the basic anti-dictatorship movement. The environmental movement, as a cultural and political phenomenon, with a decade's delay in relation to the developed world, was underway.

The second issue which drew public attention to the environmental question was forest burning in the Amazon. The rapid colonization of the State of Rondônia in the seventies and government incentives to Amazon cattle ranching led to alarmed reaction by researchers of the region, which were soon echoed by the international press. This international attention, in turn, greatly intensified debate within Brazil, and the last few years have seen the politicization of this issue and of the environmental question in general. One of the most interesting consequences of this concern has been the effort to guarantee the continued presence of native populations in the region. These "forest peoples" – Indians, rubber-tappers and peasant farmers – have been the object of considerable research and debate. The concern has been fed by the movement to defend these native groups and by those searching for sustainable development strategies for the Amazon. The goals of development, the relation between its material and non-material benefits, and the basic relation between man and nature are questions raised within this framework.

As counterpoint to the Amazon question, the devastation of the Atlantic Forest has also gained increased attention. Its conservation has benefited from the political importance of drawing concern to this region, which has already lost 95 per cent of its forest cover and which contains the major part of Brazil's urban-industrial sector. The internationalist tone that the Amazon question has acquired generates a defensive, nationalist posture which tends to diminish the centrality of the larger

environment/development issue. The Atlantic Forest, which once covered the states from Rio Grande do Norte to Rio Grande do Sul, is nearly invisible on the international environmentalist map. Its preservation and conservation, extremely important from an ecological point of view, can be promoted without suggesting subservience to foreign pressure. This region, indeed, contains innumerable species of plant and animal life whose importance has yet to be evaluated. The largest intact portions, in Rio de Janeiro and São Paulo, are home to Indians and to peasant farmers and fishermen whose livelihoods are threatened by urbanization, by tourist development and by preservationist policies of state and national governments. In summary, the region encompasses the same dilemmas as the Amazon, but has a much lower international profile.

These issues have encouraged a local environmentalist movement and political and scientific attention. They also represent the two poles of the environment/development question. What are the limits within which modern urban-industrial life must operate? How are traditional cultures and environmental sanctuaries to be preserved against the encroachment of this life? How are these concerns compatible with the economic growth necessary to alleviate poverty and promote social justice? Air pollution, water and sewage treatment, toxic waste dumps, exposure to industrial and domestic contaminants, green space, etc., are questions fundamental to the quality of life in the metropolitan areas of São Paulo (20 million) or Campinas (1 million) or the "California Brasileira" represented by the Paulista interior (4 million). But simultaneous with environmental problems resulting from industrial development are those related to the survival of indigenous groups and their more primitive (and sustainable) relationships with the environment. Brazil thus faces environmental problems of both development and underdevelopment. The challenge that this double dilemma presents has only recently been recognized by Brazilian social sciences.

## 5. Conclusion

The evolution of perspectives on population and environment in Brazil, then, have been marked by recent political history, by debate on models of economic development and by sometimes ambiguous and often tense relations between Brazilian and developed country intellectuals. Somewhat independently of all this, women have taken the matter into their own hands and have surprised both politicians and demographers with one of the world's most rapid fertility declines. And the environmentalist movement has gained momentum at a rate unexpected by its most dedicated activists.

The role of international thinking, international pressure and international experience in these areas has been important but has not resulted in automatic absorption of theory or practice. As the volume of the debate gets turned down, much fruitful exchange will occur. The question is posed for further research by sociologists and historians of social thought, but the prospects for a more relaxed and productive dialog within Brazil and between Brazilian and international traditions have been increased, and this is an accomplishment to be commemorated.

## Footnotes

<sup>1</sup>The National Academy of Sciences (NAS) of the United States published, in 1986, an evaluation of the relationships among population, development and environment which is representative of the shift away from simpler visions of other times. With the participation of well-known students of the American scientific establishment, the Working Group on Population and Economic Development substituted unidirectional formulations with an effort to examine the *mechanisms* involved. Organizing its analysis on the basis of questions which identified the basis of the relationship, the NAS asks: "Will slower population growth increase the growth rate of per capita income through increasing per capita availability of exhaustible resources? Will slower population growth increase the growth rate of per capita income through increasing per capita availability of renewable resources? Will slower population growth alleviate pollution and the degradation of the natural environment? Will slower population growth lead to more capital per worker, thereby increasing per worker output and consumption? Do lower population densities lead to lower per capita incomes via a reduced stimulus to technological innovation and reduced exploitation economies of scale in production and infrastructure? Will slower population growth increase per capita levels of schooling and health? Will slower population growth decrease the degree of inequality in the distribution of income? Will slower population growth facilitate the absorption of workers into the modern economic sector and alleviate problems of urban growth? Can a couple's fertility behavior impose costs on society at large?"

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## CHAPTER 13

# FRONTIER MIGRATION AND ENVIRONMENTAL DEGRADATION IN DEVELOPING COUNTRIES: EXPERIENCES FROM NEPAL AND ECUADOR

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### 1. Introduction

This paper assesses the causes and environmental consequences of frontier migration in low-income countries based on the experiences of Nepal and Ecuador. Our assumption is that although frontier migration in these countries and elsewhere is mainly a demographic response associated with rapid population growth since the 1950s, it is also an economic response to unequal land distribution, lack of alternative employment opportunities and government resettlement policies in frontier regions. We note that while Nepal and Ecuador are at different levels of economic development (per capita GNP of \$170 for Nepal and \$1,010 for Ecuador in 1991) and have very different histories and cultures, they also appear to have important similarities in terms of the causes and consequences of internal migration from highland to lowland areas<sup>1</sup>. Relevant similarities and contrasts will both be noted below as appropriate. The next brief section reviews the population growth and distribution situation in Nepal and Ecuador. Section 3 then discusses migration and environmental change in more detail in Nepal, followed by similar assessment for Ecuador in Section 4. The final section draws the discussion together and makes some policy recommendations.

### 2. Population Growth and Out-migration: Nepal and Ecuador

Nepal and Ecuador have experienced rapid population growth, especially since the 1950s, and have had roughly similar rates of population growth over the past three decades. During 1965–80, population growth rate in Ecuador reached its peak at 3.1 per cent per year—one of the highest in the world. But as a result of a substantial decline in fertility, it has since tapered off to 2.4 per cent per year during the last intercensal period 1982–90, and is currently about 2.1 per cent per annum. The population growth rate recorded for Nepal between 1940 and 1952–54 was 2.3 per cent per year, increasing to its peak of 2.7 per cent per year during the intercensal period 1971–81. It has since fallen somewhat to 2.1 per cent per year during the 1981–91 period due to a modest decline in fertility (mortality continues to be higher in Nepal than Ecuador, with the infant mortality rates in 1990 being 128 and 63 per 1000 live births, respectively) (United Nations, 1992).

As a consequence of out-migration from highland to lowland areas, both Nepal and Ecuador have experienced significant growth of their populations in the previously sparsely populated lowland areas. A substantial in-migration into the Tarai region mainly from the hill region since the 1950s increased its population from 2.9 million in 1952/54 to 6.5 million in 1981 and increasing its share in the total population from 35 to 44 per cent. In 1991, the Tarai's population exceeded 8 million, making its share the largest of the three regions (47 per cent) in the country. The population growth rate in the Tarai in 1971-81 reached its highest level (4.2 per cent per year), compared to the national average of 2.7 per cent (Nepal, His Majesty's Government, 1993b).

Ecuador has experienced significant migration from the Sierra to the coastal region since the 1940s, and more recently from both the Sierra and coastal regions to the Amazon. According to the 1990 census results, in-migration into the Amazon region has contributed to unprecedented population growth in the region at a rate exceeding 5 per cent per year, or twice the national average (Pichon and Bilsborrow, 1992). The population in the Amazon region more than doubled between 1974 and 1990, from 173,471 in 1974 to 372,533 in 1990; the largest increase was in the two northern provinces (Napo and Sucumbios), where it increased from 62,186 to 180,339 (Southgate and Whitaker, 1992). At the time of the 1982 population census, almost half of the Amazon region's population was born outside the region, with two-thirds of the in-migrants being from the Sierra (Hicks *et al.*, 1990).

### **3. Causes and Consequences of Migration in a Frontier Region: The Case of Nepal**

#### **3.1. Historical Legacy of Subsistence Farmers and Government Policy**

The hill region of Nepal has long been settled, with the mountain region being largely uninhabitable and the southern Tarai malaria infested, only sparsely populated by malaria-immune aborigines and some Indian immigrants until the mid-twentieth century. Throughout the 18th and 19th centuries, land in the Tarai was considered abundant relative to the small population (Regmi, 1978). Its history of skewed land distribution started when the Gorkha state was involved in territorial expansion from 1769 to 1816 and lands (considered state property) were generously granted as rewards and emoluments to civil and military officials, members of the nobility, chieftains and other key state employees. On the other hand, the numerous poor peasants, living at a subsistence level, were required to supply free labor to the state and pay rent and taxes, or face eviction (Regmi, 1971:54).

The practice of awarding lands to important persons in the royal families and nobility continued throughout the 19th and early 20th centuries even after the end of the expansionist policy. This has led to the creation of a small landed, rent-receiving class and a large poor farmer class not only living at a subsistence level but also in debt (Regmi, 1978). The peasants, thus faced with such a hard life in

the hill region, have consequently resorted to permanent or temporary international out-migration to places such as Assam, Sikkim, Bhutan, Darjeeling and even Burma (Gurung, 1989; Shrestha, 1990). The recruitment of Nepalese soldiers in the British Indian Army after the Anglo-Nepal treaty of 1816 gave further impetus for the hill people to emigrate. If it was the oppressive land and labor policies that led to out-migration from the hill region to the Tarai in the pre-1950 Nepal, it appears to have been mainly the demographic effects of subdivision and fragmentation of land and inadequate production of small farmers after 1950.

Nepal has experienced rapid population growth, especially since the 1950s. Without concomitant growth of industries, this has led to increased population density on agricultural lands especially in the hill region. With the custom of partible inheritance among sons, the results have been increasing subdivision and fragmentation of landholdings. The average size of landholding per household has thus been smaller in the hill region compared to the Tarai, though the difference seems to be narrowing due to migration (Table 1). Thus in 1961 the average size of landholding per family was only 0.50 ha in the hill region compared to 2.29 ha in the Tarai region. A rural economic survey as early as 1965-66 revealed that over 50 per cent of the households in the Tarai had 2 ha or more land (Gurung, 1984:167). In contrast, near landlessness is widespread in the hill area: according to the ILO/Asian Employment Program Mission report in 1974, although the proportion of landless households in the hill region is less than 1 per cent, 59 per cent of farm households possessed less than 0.2 ha (Rizwanul *et al.*, 1982:42).

**Table 1. Nepal: Average Land Holdings per Household by Ecological Region, 1961-91**

Regions	Average Size of Land Holding/Household (ha)			
	1961	1971	1981	1991
Mountains	-	0.47	0.62	0.68
Hills	-	0.56	0.90	0.77
Mountains + Hills	0.50	-	-	-
Tarai	2.29	1.63	1.47	1.23
Nepal	1.15	0.96	1.12	0.95

Note: 1971 average holdings per household was based on cultivable land, whereas for other years, it was based on total holdings of farm households.

Sources: Nepal/His Majesty's Government, 1974, 1988 and 1993a; Dhital in Gurung, 1981.

A Land Reform Program, implemented in 1964, was proved largely ineffective in changing the agrarian structure (Regmi, 1976). Since it was implemented in stages, big landholders were able to evict tenants and distribute lands among family

members and relatives beforehand. The reform also encouraged landowners to acquire land for individual cultivation and resulted in the displacement of small tenant farmers (Kansakar, 1983:246). Thus many of these small landholders in the hill region opted for migration to the Tarai in the hope of acquiring land. If we can ignore serious questions about the reliability of the agricultural census data on which Table 1 is based, then it would appear that holding size in the hill region improved somewhat after the 1970s. If so, inter-regional migration may have contributed to this. Between 1971 and 1981 the number of households in the hill region increased by only 14 per cent compared to 40 per cent in the Tarai (Nepal, His Majesty's Government, 1987). This coincides with the largest population growth rate (4.2 per cent) in the Tarai during the 1971-81 period due mainly to in-migration.

The 1981 census gives a rough idea of the importance of land and agriculture for the hill migrants. According to this census, of the total life-time net migrants from the hill region to the Tarai region (424,711), more than 50 per cent gave "agriculture" as their reason for migration (Gurung, 1989). Later migrants were also attracted by the availability of better socio-economic facilities in the Tarai. A survey of 5,621 households carried out in 10 Tarai districts in the early 1980s found that 16 per cent of the migrant households were attracted by access to better transport, market, education and health facilities (ibid., 1989:87). Except for Kathmandu in the hill region, the focus of development plans started since 1956 has been on agriculture and road development in the fertile Tarai plain. For example, between 1969 and 1983, the Tarai's percentage share of roads in the country increased from 34 to nearly 51 (ibid).

Migration of the hill population to the Tarai region was also encouraged by planned government resettlement programs and malaria eradication programs carried out since the 1950s. The high incidence of malaria in the Tarai led to failure of earlier attempts by the state to attract hill people. The provision was even made in the legal code by rulers in the second half of the 19th century entitling alienation of Tarai land to foreigners through sale or purchase, mainly to attract Indian immigrants. Nevertheless, deforestation was proceeding, albeit slowly in many districts of the Tarai even in the first quarter of the 20th century, stimulated in part by demand for wood from the sal tree (*Shorea robusta*) for use in Indian railway sleepers (Kansakar, 1985).

The government-sponsored resettlement program, started initially to resettle victims of the 1954 flood and landslide, was soon thereafter institutionalized. In the First Five-Year Development Plan (1956-1960) the Rapti Valley Development Program (RVDP) was launched in Chitwan district of the Inner Tarai region with the objectives of relieving population pressure in neighboring areas, rehabilitating landless peasants, and partially solving food problems in the Kathmandu valley. From 1954 to 1960 the RVDP had distributed 27,759 ha of land among 5,233 families (Kansakar, 1983:236). To resettle the landless peasants in a more planned way and to control reckless deforestation, in 1964 the government created an autonomous body, the Nepal Resettlement Company. In 1969, a full-fledged Department of Resettlement was created.

As resettlement progressed and available forests decreased, the plot size allotted to settler families decreased (as also occurred over time in the Brazilian Amazon). For instance, in the beginning, the policy of the Nepal Resettlement Company was to allot 2.7 ha to each approved family. But as land became scarce, plots allotted to government settlers decreased to 2 ha by 1972, then in the mid-1970s to only 1.02 ha. Families settled after 1987 have reportedly been given only 0.1 ha (Shrestha, 1990:193). Between 1974-75 and 1991-92, more than 80,000 families were resettled (Table 2), but this does not reflect the large volume of spontaneous settlers encroaching on forests illegally and thus the real extent of deforestation. Despite the large number of families settled, the volume of spontaneous settlers, has remained large (Gurung, 1989).

Although the government has now ended official resettlement programs in the Tarai region since 1981 (Kansakar, 1985), it is still faced with a large problem of continuing encroachment by squatters. The Official Report of the Nepal Resettlement Company in 1980 states that so far it had resettled 37,000 encroachers (Shrestha, 1990). Indeed, according to a statement issued by the Ministry of Forests and Soil Conservation in December 1992, in the Far-Western Tarai district of Bardiya, more than 2,600 squatter households were actually removed and more than 5,000 ha of forest land were thereby preserved from being encroached upon in the fiscal year 1991/92.

**Table 2. Nepal: Land and Households Resettled in the Tarai**

Fiscal Year	Land (ha)	No. of Households	Average Land per Household
1974/75-1980/81	31,262	36,348	0.86
1981/82-1991/92	16,272	44,055	0.37
Total	47,534	80,403	0.59

Sources: Gurung, 1989; Nepal, His Majesty's Government, 1993a.

### 3.2. Deforestation in the Tarai

The main environmental correlate of in-migration to the Tarai is large-scale deforestation. Since the main motive of migrants moving to the frontier region was land for agriculture, the impact of land extensification (Bilsborrow, 1987) on deforestation in the Tarai appears to have been enormous, though estimates of deforestation vary widely. In 1963-64 the first ever inventory of forest resources based on aerial photographs found 3 million ha of forests remaining, indicating that 51 per cent of the Tarai was under forest. By 1978-79, about 44 per cent of the area remained under forest. Between 1978-79 and 1991, the total forest loss in the Tarai region was estimated to be 415,000 ha, or at an annual rate of 3.3 per cent per year (calculated from data in Gurung, 1989 and Forest Survey and Statistics Division in Nepal, His Majesty's Government, 1993a). This represented a considerable increase in the pace of deforestation compared to earlier years.

Table 3 provides aggregate data on population dynamics and forest loss in the Tarai region for several different time periods. The Eastern Tarai had the lowest population increase due to net migration in 1961–71 but the largest forest loss, whereas the Western Tarai, despite a comparatively large population increase due to net migration, had a forest loss less than 1 per cent per year. It is thus clear that other factors besides in-migration must be involved in the deforestation process. Indeed, the Eastern Tarai, with over 2 million people even by 1971, had by far the highest population density in the Tarai (205 persons/km<sup>2</sup>, compared to a national density of 79). This higher density puts forests in the region at greater risk of being cleared. The Central Tarai had both a large population increase due to net migration between 1961 and 1971 and a high forest loss over 1 per cent per year. In the Western Tarai, while population size and density are relatively low, both are rising very rapidly recently partly due to heavy in-migration. This is associated with a very high forest loss of 3 per cent per year during the most recent period from 1974–75 to 1991. It is also important to note that although the proportionate increase in population due to net migration has decreased in the Tarai region between the successive censuses, second-generation impacts may now be increasingly felt to the extent the children of migrants stay in the region. Unfortunately, there are no direct data on this topic in Nepal.

In addition to population growth, density and in-migration effects, economic factors have undoubtedly played important roles in the Tarai deforestation. In particular, commercial exploitation of forests by timber interests is also partly responsible for forest clearing and use in the Tarai. The construction of the East–West Highway (969 km. in total) and other roads linking important centers of the hill region to the Tarai, not only helped increase the flow of migration and the destruction of forests in the Tarai (Jha, 1993) but also facilitated commercial exploitation of the forests.

The demand for land in the Tarai has persistently exceeded targets set by resettlement plans. As a result, there has been large-scale encroachment into forests. According to the Fifth Development Plan (1975–80), between 1964 and 1974 forest land cleared for official settlement amounted to 77,700 ha, but an additional 237,600 ha was lost by encroachment due to spontaneous migration. In addition, there appeared to be rampant malfeasance and nepotism in the distribution of land by the government (Kansakar, 1985:114), and many landless and natural disaster victims were able to obtain land (Shrestha, 1990). Those who were unable to get land through official channels formed a large cadre of spontaneous settlers.

Large-scale destruction of Tarai forests in the Bhabar region in the north, with its deep alluvial soils mixed with sand, pebbles and gravels, has also had immense impacts in the southern Tarai. Much of the northern part was not suitable for agriculture, with its forests serving as a check for the fast-flowing hill rivers entering the Tarai. Thus the destruction of its forests has resulted in increasing floods in the Tarai plains (Kansakar, 1985:117). The massive flood in the summer of 1993 in the Tarai region, with the largest number of reported flood deaths in Nepal this century, is a grim reminder of the consequences of environmental destruction.

### 3.3. The Condition of Migrant Settlers in Nepal

Although the deforestation of valuable forests is a source of environmental concern, another important issue is whether frontier migration has helped in improving the economic conditions of the migrants themselves. In the case of Nepal the answer seems mixed. According to Shrestha (1990), the previous socio-economic background of migrants and their present aspirations both play important roles in land acquisition and achievement on the frontier. Moreover, land speculation is another important fact in the frontier region: as the flow of migrants continued to rise, land transactions became common, even though the sale of government allotted plots was supposed to be prohibited for 10 years after resettlement. But new migrants were always willing to buy land from previous settlers even though the latter did not have legal land titles (ibid, 1990:229). Some of the latter in fact were simply professional squatters involved in land speculation. In one resettlement project area (Nawalpur), 50 per cent of the original settlers sold their land and moved elsewhere. The poor quality of land also contributed to this, as some settlers sold their allotted land and purchased better quality land elsewhere (Kansakar, 1985).

**Table 3. Nepal: Net Migration and Depletion of Forests in the Tarai Region**

Region	Lifetime Net Migrants (in 000)				Proportionate Increase in Population due to Net Migration				Forest Area (in 000 ha)				
	1961	1971	1981	1991	1961-71	1971-81	1981-9	1963-6	1974-75	Annual % Change	1978-79	1991	
West	20.6	69.1	238.9	--	0.16	0.16	--	631.8	585.9	-0.68	626.0	359.9	
Central	31.1	155.2	185.4	--	0.31	0.02	--	240.3	214.9	-1.01	232.1	182.8	
East	68.2	175.5	261.9	--	0.04	0.04	--	654.3	569.3	-1.26	404.9	304.9	
Total Tarai	119.9	399.8	686.2	915.7	0.09	0.06	0.03	1,526	1,370.1	-0.98	1263.0	847.6	

Note: For 1961, lifetime migrants are "persons residing in the place of enumeration over six months away from their place of birth", while for 1971 and 1981 they are "persons residing in regions other than their region of birth." Net migration was calculated as the difference between in-migrants and out-migrants from the region. Census regions varied from one census to the other, so the figures may not be strictly comparable.

The forested area for 1978-79 reflects different sources of data and different methods of estimation compared to 1974/75.

Sources: Gurung, H. 1969; Nepal/His Majesty's Government, 1993b. The 1991 forest area is based on Forest Survey and Statistics Division satellite images and field survey data in Nepal/His Majesty's Government, 1993.

A survey of 407 households carried out in 1988 in two resettlement districts of the Tarai found that the decreasing availability of land on the frontier, as migration increased, has led to increasing squatter settlement and encroachment on forest margins (Shrestha *et al.*, 1993:790). According to this survey, of the 84 households who were landless prior to coming to the Tarai, 56 per cent received land from the government while 14 per cent self-occupied it, 8 per cent purchased it, and 22 per cent remained landless. In total, including the landless and those with some land in the hill region prior to migration, 47 per cent had received land through purchase, 14 per cent through self-occupation, and 26 per cent from the government, while 13 per cent remained landless (*ibid.*:799). The majority of the previous subsistence farmers and smallholders from the hills thus had to purchase land, and did not receive any assistance from the government.

If migrants' welfare is determined by the amount of land possessed, based on the survey carried out in 1988, 66 per cent of the total sample of migrant households had made at least some absolute gain over what they had in the hill region prior to migration. On the other hand, 28 per cent had less land compared to before and 6 per cent experienced no change (*ibid.*:807). But in such a narrow measure of welfare, income level, health, education, housing quality and access to markets and amenities are not considered. From the migrants' own perspective, despite the usual small size of holdings, 85 per cent of sample households stated that their economic situation in the Tarai was better than it had been in the hills prior to migration, 8 per cent about the same, and only 5 per cent worse (*ibid.*:809).

Nevertheless, in the case of Nepal, frontier migration has not helped solve socio-economic inequalities. In fact, data show that land distribution is even more skewed in the Tarai than in the hills. In 1981 about 46 per cent of Tarai households with less than 0.5 ha, accounted for only 3 per cent of the total cultivated area, whereas the 14 per cent of the households with more than 3 ha accounted for nearly 58 per cent of the total cultivated land (Yadav, 1987). The landholdings migrants receive are generally too small, especially those of later migrants: "... almost 50 per cent of the sample migrant households were still landless and near landless ... If one takes into account the subsistence class, the percentage of the migrant population with 1 ha or less land goes up to almost 75 per cent" (Shrestha, 1990:217). With such small holdings, prospects for significant economic betterment of migrant families are dim, even though they see themselves as better off.

## **4. Frontier Migration and Deforestation: The Case of Ecuador**

### **4.1. Historical Legacy of Subsistence Farmers and Government Policy**

As in Nepal, the population of Ecuador has long been concentrated in the highlands (Sierra) region, the coastal region, with its heavy but uneven distribution of rain, and the Amazon region, with its very humid climate, being much less hospitable areas. Since the 1950s however, with the banana boom and decline in malaria in the coastal region, people from the highlands have often migrated to the coast. Now a slight majority of the total population resides in the coastal region. But more recently, since

the discovery of oil in the Amazon and the subsequent construction of roads linking this region with the Sierra beginning in the early 1970s, the Amazon region has also begun to experience a substantial flow of migrants, primarily for land colonization. The environment of the Ecuadorian Amazon region, with its extremely rich biological diversity (Myers, 1986) is, however, quite fragile. It is a home to innumerable rare species of plants, birds, fish, and mammals, but is mired in a conflict between the needs of conservation vs. the need for exploitation of its resources for development, as more and more oilfields are discovered and brought into production.

As a legacy of its Spanish colonial history and prior Inca civilization, land distribution has long been highly skewed in the Sierra region, with large landowners invariably of Spanish descent. In 1954 there were around 3,000 large haciendas in the Sierra, with an average size of 650 ha (Peek and Antolinez, 1980:2). They constituted only one per cent of the farms but occupied two-thirds of the cultivated land. These lands traditionally operated under a system of servant labor, called *huasipungo*, in which primarily Indian farmers had access to small plots of land for producing for subsistence needs in return for providing work to the hacienda owner. This work included both work on the other lands of the hacienda as well as by the farmer's wife and children in and around the hacienda building as servants, cooks, etc. The Indians were essentially tied to the hacienda for life, and unable to migrate away. In addition, of the other Sierra farmers 32 per cent in 1954 had less than one ha and together accounted for only 1 per cent of the total farm area (ibid.). Meanwhile, only about 15 per cent of the large hacienda area was cultivated on average, so the small landholders' opportunities for employment were limited. The majority of these smallholdings were too small to support a family, thus condemning them to poverty.

A major land reform program in Ecuador in 1964 abolished the *huasipungo* system and related forms of servant labor, and declared that farmers were to receive the land they cultivated, with the land reform agency (IERAC) to provide credit and technical assistance and organize farmers into cooperatives. But while land reform changed the method of cultivation and "freed" the servant laborers (e.g. to migrate), it did not significantly change the distribution of land (ibid:12). Based on the only subsequent data available (and unfortunately the most recent agricultural census, carried out in 1974), the 65 per cent of the farms which had less than 5 ha still accounted together for only 7 per cent of the farmland, while at the other end the 2.4 per cent of the farms with over 100 ha had nearly half (48 per cent) of all the farmland (Bilsborrow and Peek, 1992:365). Landowners had often avoided expropriation by simply dividing land among many family members (creating also many absentee landlords). At the same time, many of the large farms shifted into cattle and milk production, converting cropped land into pasture, facilitated by loans from government agencies. The fate of the smallholders was actually in a sense worsened by land reform, as they were no longer protected by landowners and provided with small dwellings, plots and tools. Also, because of the shift of haciendas increasingly into low labor-intensity pasture, farm laborers have increasing problems finding farm work. Among those who did have small farms, the average size of those farms with less than 5 ha decreased from 1.61 to 1.45 ha during the period 1954-74 (Peek and Antolinez, 1980:14). It is likely that this decrease is associated with rural population growth due to declining mortality, and to fragmentation of plots over time due to division among children (regarding Guatemala,

see Bilsborrow and DeLargy, 1991), but this link has not been made by any scholars of agrarian change in the Ecuadorian Sierra.

By the 1970s, many peasant families in the Sierra were surviving by earning a significant part of their income from temporary labor out-migration. In addition, according to a detailed migration survey conducted in the region in 1977-78, over 50 per cent of the households with farm sizes less than 5 ha had permanent out-migrants in contrast to only 27 per cent of those with more than 10 ha. The small farms had extremely high intensity of labor use but their size limited their labor absorption (Bilsborrow and Peek, 1992: 364-365); as a result, often some family member had to out-migrate to seek off-farm employment as a family survival strategy (ibid:367).

During the time when Ecuador experienced its highest population growth in the 1960s and 1970s, the problem of rural poverty associated with the highly skewed distribution of land was probably aggravated. Thus, in the absence of any real redistribution of land, land reform was a factor "in stimulating a part of the rural population to migrate elsewhere, either to [other] rural areas where there is land and employment more readily available, or to the towns and cities" (Redclift and Preston, in Preston, 1980:59). The state was also more active in encouraging colonization in the Amazon than in carrying out land reform in the Sierra (ibid:55). Thus the Amazon region has been viewed by the government as an "escape valve" for people without much land, especially in the Sierra. Public forest lands in the Amazon can be converted into a settler's private plot if (s)he presents evidence of agricultural use or cattle production, according to the 1978 Law for the Settlement of the Amazon, which also encouraged settlement of the Amazon region as an urgent national priority (Hicks *et al.*, 1990:7) because of concern about Ecuador's border security with such a low population density (Pichon, 1992). This concern was strongly motivated by the fact that Peru, with superior military force, forcibly seized over half of Ecuador's Amazonian lands in 1942 while the major powers were engaged in World War II.

#### 4.2. Deforestation in the Amazon

As in many other parts of the world, estimates of deforestation in the Ecuadorian Amazon vary greatly. According to Cabarle *et al.* (1988, quoted in Hicks *et al.* 1990:15), 75,000 ha of lowland forests are being cleared annually in the Ecuadorian Amazon. Population increase is highest in the northern two Amazonian provinces of Napo and Sucumbios, at a rate of 6.5 per cent per year, where the forest loss is estimated at 1.5 per cent per year (Table 4). The province of Zamora Chinchipe has the second largest annual increase in population in 1974-90 and the highest percentage forest loss of over 4 per cent per year, while Pastaza had the lowest percentage forest loss. But given the large differences in initial endowments of forests across provinces, it is much more relevant to examine the relationship between the absolute loss of forests and population growth (which is always due to both natural increase and net migration). Thus Napo and Sucumbios had the largest absolute increase in population, as well as the largest forest loss in absolute terms (770,000 ha) among the four province areas; but because of its large initial forest area, they experienced only a small annual percentage loss. Meanwhile, the provinces of Zamora Chinchipe and Morona Santiago had the next largest population increases in absolute terms and also had the second and third largest forest losses, while Pastaza had the lowest absolute increase in

population and also the lowest forest loss (250,000 ha). The fact that the forest loss in Morona Santiago (550,000 ha) was higher than in Zamora Chinchipe may be attributed to its population density. Thus as in the case of Nepal, population density and the initial stock of forests should both be taken into account in looking at the relationship between the rate of forest destruction and population change. On the whole, there does appear to be a closer relationship in the Ecuadorian Amazon than in Nepal between population growth and the rate of forest loss based on these "ecological" data. But more work is needed at a more disaggregated level to sort out the effects of demographic and non-demographic factors.

**Table 4. Ecuador: Population and Forest Change in the Amazon**

Provinces	Population (in 000)			Annual % Change	Forested Area (000 ha)		Annual % Loss
	1974	1982	1990	1974-90	1965	1984	1965-84
Napo and Sucumbios <sup>1</sup>	62.2	113.0	180.3	6.5	3,270	2,500	-1.5
Pastaza	23.5	32.5	41.8	3.7	3,500	3,250	-0.4
Morona Santiago	53.3	70.2	84.2	3.0	1,300	750	-3.0
Zamora Chinchipe	34.5	44.8	66.2	4.2	700	300	-4.4
Ecuador	6.826.0	8.605.0	10.587.0	2.9	16.250 <sup>2</sup>	12.400 <sup>3</sup>	-1.8

<sup>1</sup> Data are presented for both provinces together to achieve comparability over time, since Sucumbios is a new province created out of the old Napo province in 1990.

<sup>2</sup> 1969-71

<sup>3</sup> 1985

Sources: Southgate and Whitaker, 1992, originally from INEC, 1977, 1985 and 1991 and SUFOREN; FAO, 1993; World Bank, 1987 and 1993.

In the country as a whole, the recent rate of forest destruction is 1.8 per cent per year, most in the Amazon region. Since the initial size plot of land (40-50 ha) the settlers receive from the government's land titling agency (IERAC) is relatively large in the Ecuadorian Amazon, the land use decisions of existing settlers will also continue to have significant impacts on future deforestation. While a few large corporate plantations of cash crops in the area, such as palm oil and tea, use capital-intensive technology and modern inputs, the vast majority of settlers use a simple hand-tool technology and practise a mixed system of cultivation: subsistence food production for family consumption, a small vegetable garden, a pasture area which tends to increase over time, and an area devoted to cash crops, mainly coffee. Much of the plot remains forested, varying with the duration of settlement, size of family, and the farm and off-farm activities settler families are involved in. The land use practices of farmers often evolve over time from initially clearing a small patch for subsistence food production to clearing a larger area for cash crops, and then, once cash income starts coming in,

using it to clear a much larger area for pasture and cattle. A long-term goal of settlers is to acquire cattle, for at least four reasons: because it yields a higher income with less labor, because it provides a store of wealth which can be drawn upon or sold in case of sudden need or emergency, because it is easy to market ("the cattle do it themselves," the settlers say, by walking to market), and because it gives status. In addition, the conversion of forest land into pastureland is also encouraged indirectly by state policies that provide Banco de Fomento loans for cattle acquisition.

#### **4.3. The Condition of Migrant Settlers in the Amazon**

In 1990 Pichon and Bilsborrow carried out a detailed representative household survey covering about 420 settler families in the Napo and Sucumbios provinces of Ecuadorian Amazon in order to understand land use decisions at the household level and their implications for deforestation (Pichon and Bilsborrow, 1990). According to that survey, 68 per cent of the sample of farm settlers came from the Sierra (28 per cent from the Coast), and 90 per cent were from rural areas, so it can be generally characterized as highland to lowland rural-rural migration. While nearly two-thirds of the settlers owned some land before migrating, most had less than 5 ha. Thus most migrants were of the "survival" type, with nearly two-thirds mentioning access to their own land (or to more land) as their major reason for migrating to the Amazon.

Since the initial plots each settler receives from the state (40-50 ha.) are large and usually laid out in a rectangular grid of 100m by 2 km plots, only two families live in each square kilometer, so settlements are usually not clustered (Pichon and Bilsborrow, 1992:13). Initially, the settlement policy produced a relatively equitable distribution of land: the Gini coefficient for land in the mid 1970s was 0.36 compared to 0.67 for the Sierra. However, with a longer duration of settlement, land acquisition by the more successful or wealthier migrants from the less successful, and increasing demands for commercially-oriented products such as cattle and palm oil, have led to a somewhat increased land concentration (Fundacion Natura, 1988, quoted in Hicks et al, 1990:17). According to the 1990 survey, landholdings of settlers averaged 44 ha, ranging from 1.15 to 400 ha. The small plots constitute only 5 per cent of the total--mainly portions of legal settler plots provided illegally for share-cropping. The largest plots reflect some consolidation of plots evolving over time.

As of 1990, 90 per cent of the sample settlers had at least a provisional land title, with nearly 50 per cent having full legal titles. Only 32 per cent of sample households had obtained their land directly from the government, with 61 per cent buying it from previous settlers, including land speculators, despite restrictions on such illegal land transactions. Among those who purchased land, 61 per cent received certificate of land titles and 39 per cent did not. Only a negligible number of households (3) reported that they had simply squatted on land. Survey responses suggest settlers are generally satisfied with their lives (as in Nepal), despite the great difficulties of life in the Amazon: about two-thirds of sample household heads stated in the 1990 survey that life was better for them in the Amazon than in their previous place of residence, 21 per cent about the same, and only 13 per cent worse.

Based upon the survey data, Pichon and Bilsborrow (1992) examined household socio-economic characteristics, institutional and ecological factors and their effects on settler decisions to clear forests. They found that most settlers have put their plots to more than one use: on average they were allocating 22 per cent for pasture, 17 per cent for perennial crops and 5 per cent for food crops, with 56 per cent still remaining in forest. Land use varies by farm size, with larger farms having higher percentages of their farm areas remaining in forest, as is to be expected. The other variables that affected land use decisions include family size (larger families clear more), possession of a secure land title, soil quality, and duration of settlement (longer duration means a larger area cleared). But the most important factors that influenced land use were logistical: the greater the distance to the nearest market or to a primary or secondary road, the less deforestation on the settler plot, interpreted as reflecting ease of commercialization of output.

Despite the perception of abundant land in the Amazon region, further settlement of the area and further deforestation cannot be expected to solve the problems associated with population pressures and inequitable land distribution in other regions of Ecuador. The fragility of soils in the region means that the perception of abundant land is deceiving. Most tropical rainforests are on soils too poor for uses other than remaining in forest. Surveys of the Amazon region in Ecuador and elsewhere indicate that limited soil fertility and poor drainage render sustainable crop production uneconomical in most of the region. In addition, its forests are among the richest in the world in biodiversity, so that continued deforestation is exacting a terrible biological price.

## 5. Concluding Remarks

Nepal and Ecuador are both countries of great physical, ecological and cultural diversity, with large, environmentally important, ecologically fragile regions. Although Ecuador's current population (11 million) is only about half that of Nepal's (20 million)—and its population density about one-quarter that of Nepal—both countries have been undergoing rapid rates of population growth and deforestation in recent decades. The populations of both countries will also continue to increase substantially for several more decades (at least) because of their young age distributions associated with past high fertility. Thus if population growth remains at its current moderate level, for example, Ecuador's population will reach that of Nepal's current population in about 30 years, while Nepal's will double to about 40 million. Agriculture will probably continue to provide a major source of livelihood for people in both countries, with strong potential implications for further deforestation.

In both countries rural-rural migration of small farmers from densely populated highland areas to lowland forest frontier regions has been the proximate cause of deforestation. Thus timber operations and large agricultural plantation operations have played only minor roles in the process. Similarly, in both cases, most migration has been spontaneous, though some was government-sponsored in Nepal (in Ecuador, the land titling agency was involved mainly in distributing land titles). Also similar in both countries is the powerful effect of roads on "opening up" the lowlands area to settlement, the insecurity of land tenure, and the predatory and uncontrolled role

played by land speculators in acquiring plots initially only to resell them for profit later to the "real" agricultural settlers.

In both Ecuador and Nepal, the desire for land has been the predominant motivation for out-migration from highland to lowland areas. In this sense, subsistence farmers with a need for survival have constituted the majority of the migrants. The skewed distribution of land and the small size of holdings in highland areas, and the absence of government policies to improve agricultural technology, contribute to inadequate incomes from land, so many farm families must resort to out-migration as the only alternative. Even in Ecuador where the discovery of oil and the construction of roads in the Amazon initially helped migrants move to the region, the main motivation was still land ownership rather than service-sector employment.

There are, nevertheless, some important differences in the deforestation and migration processes in the two countries. First, deforestation in Nepal's Tarai region has been a much longer, slower process, going on even before the construction of the major roads linking it with other parts of the country beginning in the 1950s. In the case of Ecuador in contrast, deforestation has been quite rapid and recent, mainly due to the discovery of petroleum and the subsequent unpaved road network in the northern Amazon, built by the oil companies, that facilitated settlers' migrating to the region since the early 1970s.

The abundance of land remaining to date in the Ecuadorian Amazon is another important difference between the two countries (though it may be only a matter of time before it too no longer exists). As a result, plots allocated to settlers were comparatively large in Ecuador (50 ha cf. 1-2 ha or less in Nepal). The notion of the Tarai as an "escape valve" in the case of Nepal has already proved to be false as its population share is now the highest in the country (47 per cent cf. 46 per cent in the hill region in 1991), and its density has almost equalled that of the hill region (6.6 persons/ha in the hill region cf. 6.1 persons/ha in the Tarai, according to the 1991 census). Although the Tarai's population growth has slowed down somewhat compared to earlier years (to 2.8 per cent per year between 1981-91, compared to the national average of 2.1 per cent per year), the effect of past high natural growth is increasingly felt in the Tarai as per capita landholdings have decreased due to subdivision and fragmentation. This could well occur in the Ecuadorian Amazon in the future as well. However, in much of the Amazon, poor soil quality may prompt many migrant settlers to abandon current plots once their productivity declines. This could lead to a cycle of deforestation, as has already occurred in the Brazilian Amazon.

In Ecuador, the very high fertility of migrant settlers has been noted earlier (Pichon and Bilsborrow, 1992). Thus there will also be substantial second-generation effects to the extent migrants' children remain in the region and resort to agriculture (crop cultivation and pasture) as a way of life. As the weak soils lose their fertility over time, there will be greater efforts of existing settlers to clear more forests unless other economic opportunities in the area increase substantially.

Given the different amounts of land migrant settlers have access to in Nepal and Ecuador, it will be important to continue to monitor changes in land use patterns over time in the two countries--the extent to which agricultural production increases predominantly at the intensive vs extensive margin--as population density increases.

At the macro level, when looking at the relationship between frontier migration and forest loss, it is necessary to take into account initial population density and the initial stock of forests. In any case, the complex interrelations among on-going economic processes, population growth, and environmental degradation cannot be understood adequately using only existing macro level data, so more intensive investigations based on household/farm and community level data are needed in both areas of origin of migrants and areas of destination or deforestation. Thus in Ecuador it is important to both reduce and better direct the flow of new migration into the Amazon region. This will require a careful study of the underlying causes of out-migration from places of origin. Other important areas for further research in the Amazon itself include assessing the determinants of fertility and the health problems of migrant settlers; the current and the expected economic activities of migrants' sons and daughters, and the extent of second-generation settlement and land clearing, now that many migrant families have been in the area over 15 years; and the effect of community-level conditions including policy factors, such as the availability of health facilities, education, agricultural extension services, road access, etc., on settlers' fertility, mortality, economic activities and pace of deforestation.

The other important consideration in Ecuador is the need to preserve as much as possible of the remaining rich forest resources in the Amazon. Based on the 1990 survey, over half of migrant settlers' land remains in forest, so there is a need to educate both households and communities on the importance of preserving forests, and to encourage them to become involved in the preservation of their own forest areas.

The experience of Nepal with respect to community forestry may provide an interesting lesson for Ecuador in this respect. After the nationalization of forests in 1957 and the subsequent failure of central government policies to stop deforestation, the government since 1978 has tried to involve local people once again in preserving forests around their communities by reintroducing a community forestry approach. Under this approach, the authority of forest management is delegated to local user groups, usually a village-level group with members from each of the wards constituting several villages. It makes its own rules and regulations regarding forest preservation, such as what trees to cut and when, how much to allow each household to cut, how to monitor the rules, and what punishments should be if the rules are not followed. On a broader level, such forestry management can also generate a supplementary source of income for the community "with both forest and agriculture practised as a balanced land use system" (Kayastha, 1991). Important to the community forestry approach, however, is an awareness in the local community of the importance of forests and their preservation. Promoting local community "ownership" over forest resources in the Ecuadorian Amazon--where most people have arrived only recently, and from different parts of the country--is likely to be more difficult but is surely worth pursuing, together with other policies discussed earlier (see e.g., Pichon and Bilsborrow, 1992; Pichon, 1993).

In Nepal, a new community forestry approach has thus taken shape. There is a need to study its effectiveness--its strengths and weaknesses in the hill region as well as in the Tarai, where there is greater cultural diversity in the population. At the same time household surveys are necessary to collect information to permit investigating out-migration patterns from the hill region (now that Tarai land is no longer easily

available), along with other adaptations to high population growth and scarce land in rural areas. It is also desirable to investigate demographic in comparison with other reasons for the declining size of landholdings in the Tarai, which could be done based upon the new household survey data or even aggregate agricultural census data. Above all, there is a need for a more holistic approach in forestry and population policies. For example, present programs of afforestation and family planning are likely to be more successful in contributing to environmental conservation if they are more closely integrated. But unless the quality of life of the majority of the rural population can also be raised through other development programs, such efforts are likely to have little effect in the long run.

## Footnotes

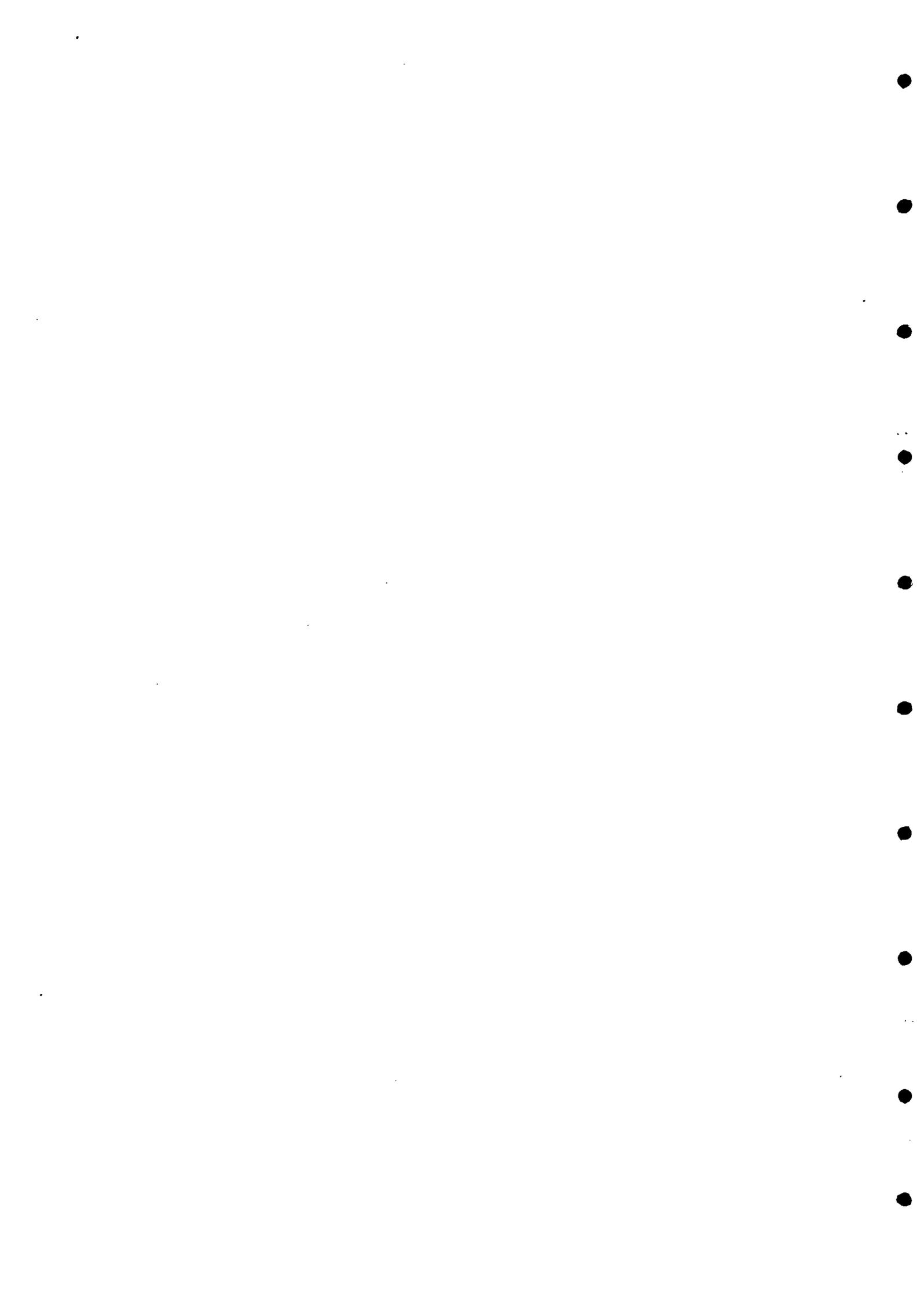
<sup>1</sup>Geographically, Ecuador can be divided into three distinct regions: a coastal region (with the largest city and seaport, Guayaquil) in the west; a highland region called the Sierra (lands in the central region, generally above 1200 meters) which contains the only other major city, the capital, Quito, in the middle; and the Amazon region in the east. Nepal can similarly be divided into three regions: a mountain region in the north (above 4850 meters), comprising less than 10 percent of the total population; a hill region in the middle with many densely populated valleys (600–4850 meters), including the largest city and capital, Kathmandu; and the Tarai region, a lowland tropical belt in the south bordering India.

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## CHAPTER 14

# LOCAL COMMUNITY APPROACH TO THE STUDY OF POPULATION-ENVIRONMENT INTERRELATIONSHIPS AND DISHARMONY: THE RELEVANCE FOR AFRICA

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### 1. Introduction: A Local Community Approach

A logical starting point for this paper is to discuss the question: what is local community approach? This implies a way of looking at issues from the local-level perspective, defining local-level problems for investigation, disaggregation, even global-level issues to their area-specific local origins in an attempt to understand the actual decision-making process and other behavioural processes involved.

In the context of the study of population-environment (P-E) interrelationships and disharmony, for instance, a local community approach implies defining local-level, relatively small-scale areas of investigation in which P-E processes operate and where disharmony problems originate. It also requires adopting methods of investigation, analysis and reporting to suit the local-level/local-area circumstances and scale of the study. In particular, it requires adopting methods of study that will enhance the aggregation of similar, comparable local-level studies from wider areas and situations, even up to the global level.

Indeed, in various respects, local communities do exist and can be defined, both in terms of human populations and of environmental processes or ecological units. They are definable functional space units within which various ecosystem processes operate, including P-E interrelationships.

Another pertinent question at this stage is why local community approach? It helps in elucidating, actually, how P-E processes operate at the levels that are really primary in the interplay of the various factors/elements, and the functioning of the processes. It enables the collecting of information/data at the local level and, thence, aggregating them to the wider regional, national and global-levels, rather than the other way round. In this way the approach helps to avoid generalizations and guesses which often blur the true situations regarding, say, the interrelationships between the different specific elements and factors of both the population and the environment

The literature regarding P-E interrelationships and consequences in many developing countries, in particular, is full of often wild guesses and sweeping generalizations especially based on the single population factor of high/rapid growth rates. This has raised the need to study P-E interrelationships at the various levels and circumstances in which they operate in Africa (and the developing countries) starting from the grass-roots (the family, household, and local community habitat).

It also helps to ensure that many crucial factors are considered, such as individual, family, household or community decision-making processes; local community group dynamics and pressures; poverty and high levels of illiteracy; information relationships; risk perception and assessment processes; levels of expectation and responses/actions towards challenges (stimuli); gender differences in knowledge and awareness, in access to and rights on resources and inputs, or in power relations and empowerment; among others. The effect of time and thus the trend in P-E relationship processes over time are also clearly revealed.

An appropriate mix of methodology for a local community approach requires a combination of scientific/probabilistic methods, rapid assessment methods and anthropological methods (especially of participant observation). And conducted with multi-disciplinary teams and input the approach helps to fill the noticeable gaps in our knowledge of the different behavioural factors and processes that operate in the P-E relationships.

When a local community approach is adopted, the local inhabitants of the study area are involved by participating in the investigation of the P-E problems. Their perception and assessment of the risks to them arising from the P-E disharmony are heightened while their local/indigenous knowledge base is drawn upon in the understanding of the origin of the problem(s), or in the various decisions and responses that precipitate or prolong the problem(s), or in finding appropriate and sustainable remedies or preventive measure for the problem(s). Hence, for effectiveness, the approach needs also to be research and development (R&D) oriented, including one or more local community self-help or assisted projects component(s).

## **2. P-E Relationships in Local Communities in Africa/Nigeria**

### **2.1. The Model**

A historical perspective to the study of P-E processes in some local communities has revealed that there is a recognizable pattern in the trend of events. This is generally a shift from a state of primitive balance and harmony between population and the local environments through time and progressively (and in some cases imperceptibly) to varying stages of imbalance and disharmony. In some areas this can get up to even catastrophic dimensions. The picture that emerges is represented in the schema depicted in Table 1 and Figure 1.

**Table 1. Phases of P-E Relationships over time in African Local Communities**

<b>Phases</b>	<b>Population</b>	<b>Resource Use</b>	<b>Environment</b>
1. Primitive balance/harmony	Low, dispersed; low expectations and intensity of activities; limited areal sphere; small aggregate human influence on environment and resources	Low relative to abundant resources; often simple technology of exploitation; incidental management around settlements; population's high dependence on natural resources and environmental influences	Virgin or near climax; abundance of species, resources; available and abundant
2. Early changing	Early increases in population, settled area, expectations and activities; emergence of group, community and societal interests and pressures	Early increases in people's activity sphere; expansion of settlement frontier increasing economic activities; local technological or management systems; early signs of strain	Early signs of increasing human activity and aggregate impact; weakening environmental influences on the people
3. Intermediate changing	Significant, often rapid, increases in population, in expectations and needs; worsening poverty; food and health crises; reduction in quality of life; increased awareness, perception and risks assessment of the P-E disharmony	Further improvements in technological and management skills, further increased economic activities; visible signs and indicators of resource over-use, reduction and degradation; expansion of the areas of the areas of resources exploitation	Increased signs and indicators of environmental degradation; risk-posing environmental changes; reduction in environmental quality
4. Later changing	Deepened population changes and problems; greatly reduced quality of life; concern and search for suitable intervention responses as population programmes	Further deterioration of various resources; increased resources use; search for resource management especially conservation measures, including sustainable techniques and practices for resource use	Deepened environmental changes and problems; greatly reduced environmental quality; search for suitable environmental management approaches and programmes
5. A. Relative balance/sustainability	Stability, with manageable changes; improved welfare	Sustainable resource-use practices	Sustainable environment-friendly behaviours; improved environmental quality
5.B. Irreversible imbalance	Extreme poverty possible decay or even extinction	Irreversible degradation	Irreversible destruction

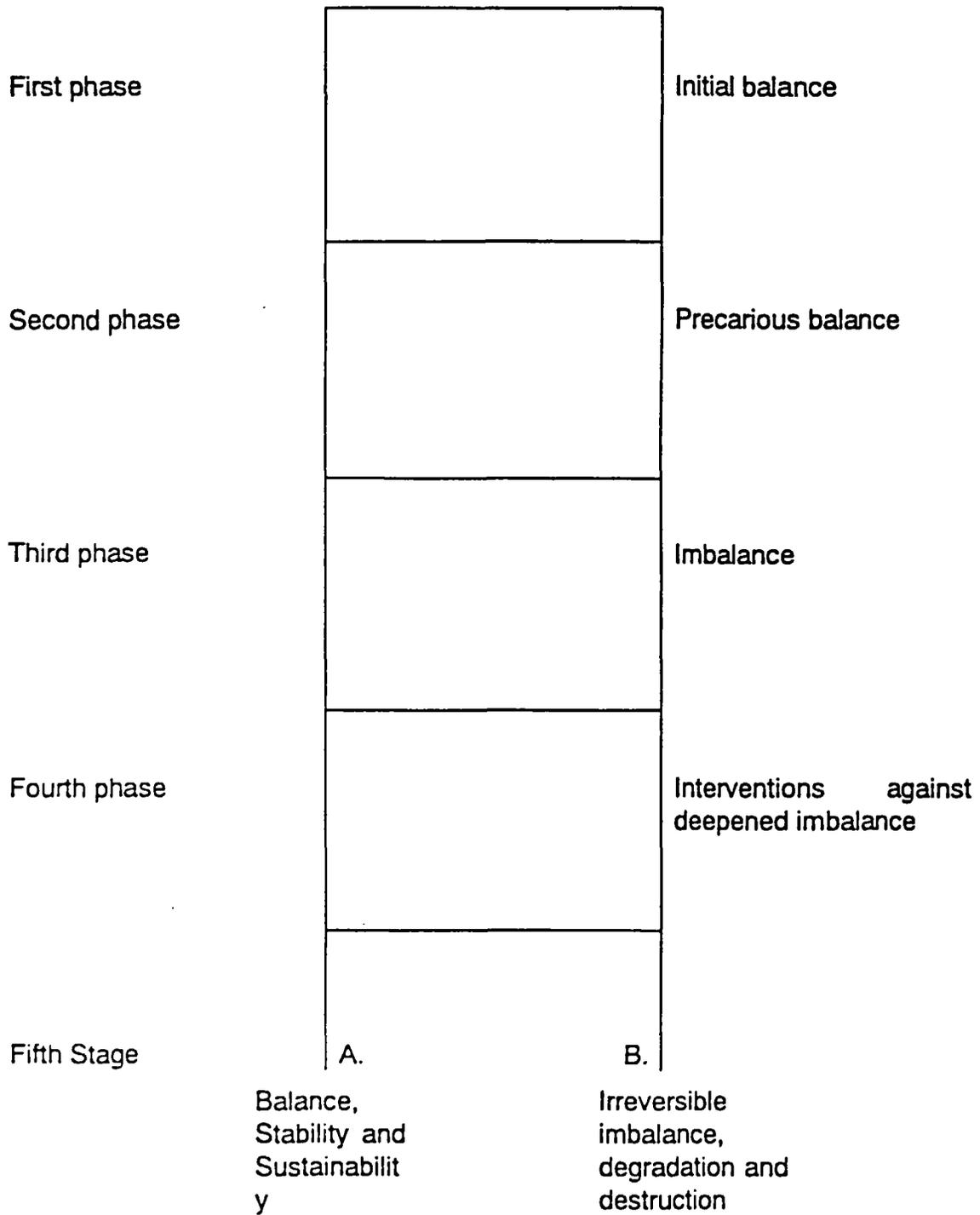


Fig. 1. Schema of the phases of P-E relationships in African local communities

The major features of the various phases are as follows:

**Phase 1: *Primitive balance/harmony phase***

This is the initial situation that exists in a newly settled/colonized area, community or region. In this phase the population size is relatively low, the distribution is dispersed, scanty and generally spotty, while the density is low and rate of increase is also low. People's expectations are relatively simple and low, leading to relatively low intensity of activities regarding resources exploitation. The technology is also low if *in situ* or as efficient or inefficient as those brought in by migrant groups/settlers. The sphere of activities (the operational space) is limited as often there is a low level of stimulus to increase activity levels. Resources management is generally only incidental or unconscious as surpluses are abundant and the limited needs/expectations are easily/readily met. Environmental influences are usually high, while the aggregate of the people's impact on the environment and resources is relatively small, insignificant or non-threatening. Over time, however, the population increases, the needs and expectations increase or the aggregate intensity of activities on the environment and resources increase, arising either from within or from outside the area, locality or region, leading to the second phase.

**Phase 2: *Early changing phase***

This phase is marked by continuing, but precarious and falling P-E balance. It witnesses early increases in population often through a combination of natural growth and immigration into the area, community or region. This is accompanied by an expansion in human settlement and activity. Thus, it is marked by expanding settlement frontier; increasing economic activity sphere; increasing extensification of activities over the increasing operational space; and increasing intensity of impact on the environment and resources following increasing needs and expectations as well as stimuli for increased activities. During this phase, there occurs also a weakening of the environmental influences of the population as a result of increasing demands, some *in situ* local technological improvements or introduction of superior/improved techniques of resource exploitation from an external area. With time early signs of environmental weakening and P-E imbalance begin to emerge; but this is often contained (especially through common property regimes of communal ownership) with management and regulation of use of the environment and resources. Considerable group, community or societal interests, pressures and influences emerge and influence both collective and individual behaviours including those affecting the P-E situation. As some of such societal values and influences could be detrimental to the maintenance of P-E balance, they and other stimuli lead over time to further deterioration in P-E balance and thence to disharmony, risks and more acute crises, heralding the next phase.

### **Phase 3: *Intermediate changing phase***

This phase witnesses considerable P-E imbalance and disharmony, largely as a result of a combination of many factors. During this period there is usually a significant and often rapid increase in the population's numbers or needs, expectations and actions (activities). Out of increased needs there occur also improvements in technological and management skills and efficiency. Increasing signs and indicators of environmental degradation, resources deterioration and reduction in the quality of life of the people emerge or worsen. There occurs also the emergence and deepening or worsening of poverty, illiteracy, diseases, and crises of food, nutrition and health. There is decreasing communal ownership and management of resources, with rising incidence of single household or family or individual ownership of resources. Considerable differentiated gender roles and responsibilities arise, while there are still persisting but weakening group, community or societal pressures and influences. During this phase, very noticeable risk-posing environmental changes occur as well as population changes, deteriorating over time, and increasing awareness, perception and assessment of the risks from the heightened P-E imbalance and disharmony. Such awareness and the concern over the risks and challenges mark the onset of the next stage.

### **Phase 4: *Later changing phase***

This phase is marked by the search for balance and sustainability, arising from deepened, desperate P-E imbalance and disharmony. There develops increasing concern for the quality and welfare of the population, for environmental quality and for sustainability of development processes. Thus, there are considerable responses to the threats, challenges, crises and risks that constitute stimuli from the P-E imbalance and disharmony. Thus too, there are concerted searches for, and efforts towards appropriate interventions, as in the form of population action programmes, as well as environment and resources management, rehabilitation and conservation programmes. This phase therefore witnesses the formulation and implementation of various models, approaches and strategies for effective population and environment action programmes and projects at different spatial levels. These are generally resorting, enhancing and sustaining P-E balance, while achieving sustainable growth and development now and for the future. Depending on whether the efforts during this phase succeed and yield the desired effects, including bringing about suitable P-E balance friendly behaviours on the part of the people (the community members), a next phase may be reached.

### **Phase 5: *Relative P-E balance and sustainability phase, or irreversible imbalance and destruction or decay***

This is an expected future phase, during which there is population stability, with manageable increases, and the people demonstrate sustainable environmental and resource-use behaviours and practices. On its part there will be relatively high environmental quality and resources sustainability. Improvements in development and people's general welfare will be relatively high and sustainable. This is expected when

the various intervention measures during the fourth phase prove successful and sustainable.

However, another path can be envisaged, although not expected, if the intervention measures do not achieve the desired objectives, or when there are no interventions. If the communities do not manage their populations adequately, do not achieve suitable environment and resource-use related behaviours, or do not evolve responses to P-E risks, challenges and stimuli, then a phase of irreversible imbalance may be reached. Such a path may lead ultimately to extinction or decay of environment, resources and human populations.

## **2.2. Reality**

So far, the P-E studies in various communities and regions of Africa have not revealed any areas falling into the fifth phase. Rather, many African local communities are today at the second or third phase, while initial efforts are being mobilized to get some on to the fourth phase. Indeed, many Nigerian local communities, for instance, which are today faced with numerous indicators of P-E imbalance and disharmony (Ajaegbu, 1992a), and are now at the third phase in this model, still recall their experiences in the first phase when, according to them, farm land was surplus, every household had enough to cultivate, crop yields were high and food was plentiful. In such days, there were no incidences of disputes and conflicts between members over farm land or settlement site. As they now report, all those have changed.

In some of the communities, such days of relative P-E balance and harmony lasted until the mid-1950s, while in others they extended well into the 1960s, depending on when their resource-use circumstances impacted markedly on the local environment. Only a few patches of virgin or almost virgin land still exist presenting characteristics of initial P-E balance. Among them are the present-day settlement frontiers, including the rather remote coastal/mangrove forest zone in Nigeria. Such areas exist today at well over 100km away from the nearest urban centre (e.g. from Benin City), or from any significant concentration of rural settlements. They are generally inaccessible with very sparse and spotty cultivated patches and, occasionally, also farm huts, at their peripheries. The southern, coastal parts of the Oredo West LGA in Nigeria's Edo. State is an example of such areas.

## **3. Some Observations**

Some communities in Africa are found in relatively very vulnerable ecological areas, with resource bases that soon prove inadequate, unreliable or non-renewable in the face of even moderate increases in resource use and general intensity of human activities. The various communities in the Sudan Sahel or other savannas and in the deserts fall largely within this category. And, as discussed elsewhere (Ajaegbu, 1992b), other highly susceptible ecological units and P-E crisis areas in the continent include the following fragile environments:

- a. The desert, Sahelian, Sudano-sahelian zone
- b. The forest zone

- c. The savanna (guinea, highland/plateau) zone
- d. The large urban areas
- e. The densely peopled rural areas and settlements.

These are generally areas, ecological zones or units, in which substantial or, even over time, marginal increases in the intensity of resource use, over-use or misuse have resulted in considerable P-E imbalance and disharmony. At the third phase, in particular, they are often characterized by factors such as low rainfall, high evaporation or drought, erosion, sand drift, gullying, soil impoverishment, reduced crop productivity, crop failures, pests and diseases, and considerable poverty. Thus, the role of the varying ecological zones and local community environmental and resource characteristics, as well as varying intensity of resource-use activities, whether by the local community population and/or by users from outside the community, seem to be the two major factors involved in the P-E balance or imbalance in many African communities.

Similarly, there are high-risk population groups in Africa regarding population change, environmental change, resource deterioration and various other indicators of P-E crisis. Also (as summarised in Ajaegbu, 1992b), they include the following:

- a. The nomadic people (and their animals) in the arid and semi-arid areas.
- b. The sedentary cultivators in the savannas.
- c. The urban poor households, males and females, the low income and the informal-sector marginal operators.
- d. The land/forest-based small-scale peasant cultivators of the forest zones.
- e. The growing number of illiterate, unskilled environmental refugees displaced and dispossessed, destitutes and beggars or, at best, menial workers; also included in this group today are the large numbers of refugees arising from political instability, crises and wars in several parts of Africa.
- f. The women and children, especially in the rural areas, who depend on the local environments.
- g. The non-landowning, land-renting or hiring cultivators, male or female, migrant, settler or indigenous cultivators in both the savanna and forest areas.

Indeed, many people in the large, expanding urban areas or in the various densely settled environmentally disturbed or fragile rural areas in Africa are today at risk regarding the processes and adverse consequences of P-E disharmony and crises.

In several African communities, studies show clearly, on the one hand, the effects of the intensity of the people's activities and resource use on the environment, and, on the other hand, the varying and continuing effects of the different environments and resource characteristics on the people's social, economic and political life. Also revealed are several local community or group influences, values and pressures which influence or even determine the types and nature of information on population or environment or even on various levels and ranges of P-E problems which individuals, women, children, adolescents or even some male or female adults get or are allowed to receive. Such beliefs, biases or norms also in many localities, influence or colour many people's perception of P-E issues, their assessment of the risks involved, their

cause-effect constructs on such problems and their responses (actions or inaction) to the P-E changes and problems.

At the local community level in Africa the role of women in P-E relationships is strong and crucial. Yet, gender differentiation in resource ownership, control and use rights tends to be strong and the balance tilted against the female (Ajaegbu, 1992c; Jackson, 1992; Kanogo, 1992). This appears to affect considerably the efforts made during phases 3 and 4 towards attaining stability, harmony and sustainability. As is still the case in many rural communities, lack of access for the women to several resources and/or sources of information, decision-making or opinion-forming sources, as well as lack of inheritance rights have denied the women the power and the zeal to make their own decisions for themselves and take independent actions about population stability, environmental harmony or sustainability of the development processes (see also ADB, 1990; Dube, 1992; Joekes, 1989; Morna, 1991).

The adoption of communal common-property management systems is reported to have helped in maintaining resource use and P-E harmony in many communities throughout phase one and well into phase 2. However, by the third phase the extent and effectiveness of communal ownership and regulation of use of several local resources, including land, have reduced so much that areas hitherto protected and managed change to private ownership and often uncontrolled or poorly managed use practices. In such places, for instance, forests reserved for various communal uses are claimed or bought by some powerful individuals. Instances have been cited of such forests covering steep hillslopes or fragile watersheds being cleared and cultivated leading within very short periods to devastating landslide, soil creep or gully erosion. Indeed, as against the relative harmony achieved generally through communities' use of common-property regimes in managing many local resources, individualized ownership and use rights have led to considerable increases in pressure on many such resources.

Besides, communal management of local community resources helps to ensure that many otherwise disadvantaged members have at least use rights. In some communities all adult tax-paying males participate in the use of some types of resources, while all married or widowed women participate in the use of some other types of local resources. Thus, overall, the communal system ensures that, say, the poor households, the women and young adults, the women-headed households (especially also if such households have adult male offspring), and all peasant farmers, male or female, have access to the use of environmental resources. Everyone so involved, therefore, also feels substantial commitment to the sustainable use of such resources.

With individualized ownership and use right, the poor groups lose access to many of the resources, get even poorer and more desperate and lose the sense of commitment to improving, managing and sustaining such resources. Moreover, many of the relatively rich members of the communities who acquire and own several such resources often no longer see their fate and survival tied to the fate of the local community. And, in that case, they may even be absentee owners, or pay little or no attention to managing and improving such resources, which ultimately deteriorate.

Studies have also shown that the role of poverty and relatively high rate of illiteracy is everywhere considerable in influencing the P-E relationships and the persistence or

deterioration of disharmony and crises. This is true of both rural and urban communities. Associated with these factors are also relatively low levels of awareness and perception of P-E issues in wider spatial contexts than the immediate local community or even than at the personal-individual or household habitational area. There is also little appreciation of causes and effects involved in both population's welfare or environmental quality. Thus, for instance, explanations for the origin of some environmental degradation, resource crisis or declining population's welfare or environmental quality often tend to be false. Thus, too, the levels of such people's assessment of the risks arising or likely to arise from their P-E decisions, actions or inactions, are in many cases low.

Poor households, women, informal-sector workers or small-holder farmers, among others, are still numerically dominant in many of the communities. The activities of such large numbers regarding either population increases and behaviours or environment/resource exploitation, management and conservation practices prove prominent in the P-E imbalance and crises in many communities. In such localities and in respect of such people, the local techniques and management systems practised are often unable to achieve sustainability. Moreover, such people are often forced or easily manipulated by a few influential and better-off members of their communities to lose their ownership of resources and thence become, say, landless. Or they are often fed with propaganda information or views that colour their awareness, decisions and actions. Such people easily resign to fate, feeling helpless, or resist some P-E improvement measures or new ideas which are objected to by the powerful (religious, social, economic) few.

Migration has proved an important mechanism regarding P-E conditions and processes in many parts of Africa. This is true of the various rural-rural movements, rural-urban migrations, waves of migrant labourers/workers or cultivators and the now frequent movement of environmental or war refugees. Migration has impacted on the P-E situation in various study communities in three main ways. First, it has led to the easing-off of the pressures in some resource-deficit and P-E crisis areas. Second, it has helped in providing the needed manpower to exploit available resources in resource-surplus areas. Third, it has over time, and following increasing migration waves and numbers, led to or precipitated P-E disharmony and crisis in some areas (see Adepoju, 1976; 1982; Ajaegbu, 1976; Udo, 1976). Thus, communities today record various levels of net-migration depending on and relating to their P-E situation.

It appears that the conditions (factors) and processes which lead to or enhance P-E disharmony are widely transported or transferred from place to place through the increasing, unending migration waves in the continent.

Too many African communities there still have religious and cultural constraints to the search for suitable approaches and strategies for tackling some of the existing P-E crises issues. For instance, some religious ideas/beliefs or cultural norms/expectations of and pressures on the people (particularly on the women, their rights and roles, etc.) account for the resistance shown to adopting some population intervention or environmental management measures in some communities.

It is necessary to state that in any one community many of these and other factors identified work in conjunction with others, rather than in isolation, to lead to or during

any phase of the P-E imbalance and disharmony. Some factors may, of course, exert more effect than others.

However, in some of the local communities, members have organized both social and development associations which have proved to be a useful framework for joint effort and enhancement to their members. Such organizations have been initiated by the adult males, the adult females, the adolescents and other age grades in the populations, in rural areas as well as in urban centres. They enable the members to discuss their various P-E problems and development issues collectively and to pool resources towards tackling such problems. Many of them are known to have embarked on or supported various P-E improvement projects in their communities. Indeed many of the local community projects which often herald or mark phase 4 are invariably initiated or strongly supported by such associations.

Cases abound in many parts of Africa of local community development, religious or social associations initiating, supporting or executing projects on, say, agricultural food production, soil improvement, rural water supply and management, or on afforestation. Others exist regarding the provision or refurbishing of various services or infrastructure such as for health, education, road access or information, education and communication, as through mass television-viewing centres. In some communities, such associations have also started financing literacy classes for adult females and males, skills acquisition training for women, or short courses for in-school or out-of-school adolescents and teenagers (male and/or female) during holiday periods on population, family-life and environmental awareness.

Rapid appraisal of the indigenous knowledge of the members of various study communities regarding their P-E processes, behaviours, crises and solutions has revealed the extent of what people know or do not know and how much they practise. It shows, for instance, different levels of awareness, appreciation of causes and effects or assessment of risks to them and to others directly and/or indirectly, at various levels from the local to the global. Furthermore, it reveals the various sources of information and their decision-making processes, such as regarding their assessment of risks or choice of solutions to different P-E problems. Thus is revealed the various channels of information and basis for responses to the P-E crisis situations, which help to explain the sustainability or non-sustainability effects of the diverse responses the communities have so far made. In this way it also indicates the basis for determining or modelling appropriate approaches to and programmes for tackling the numerous P-E disharmony problems in Africa today.

#### **4. Conclusion**

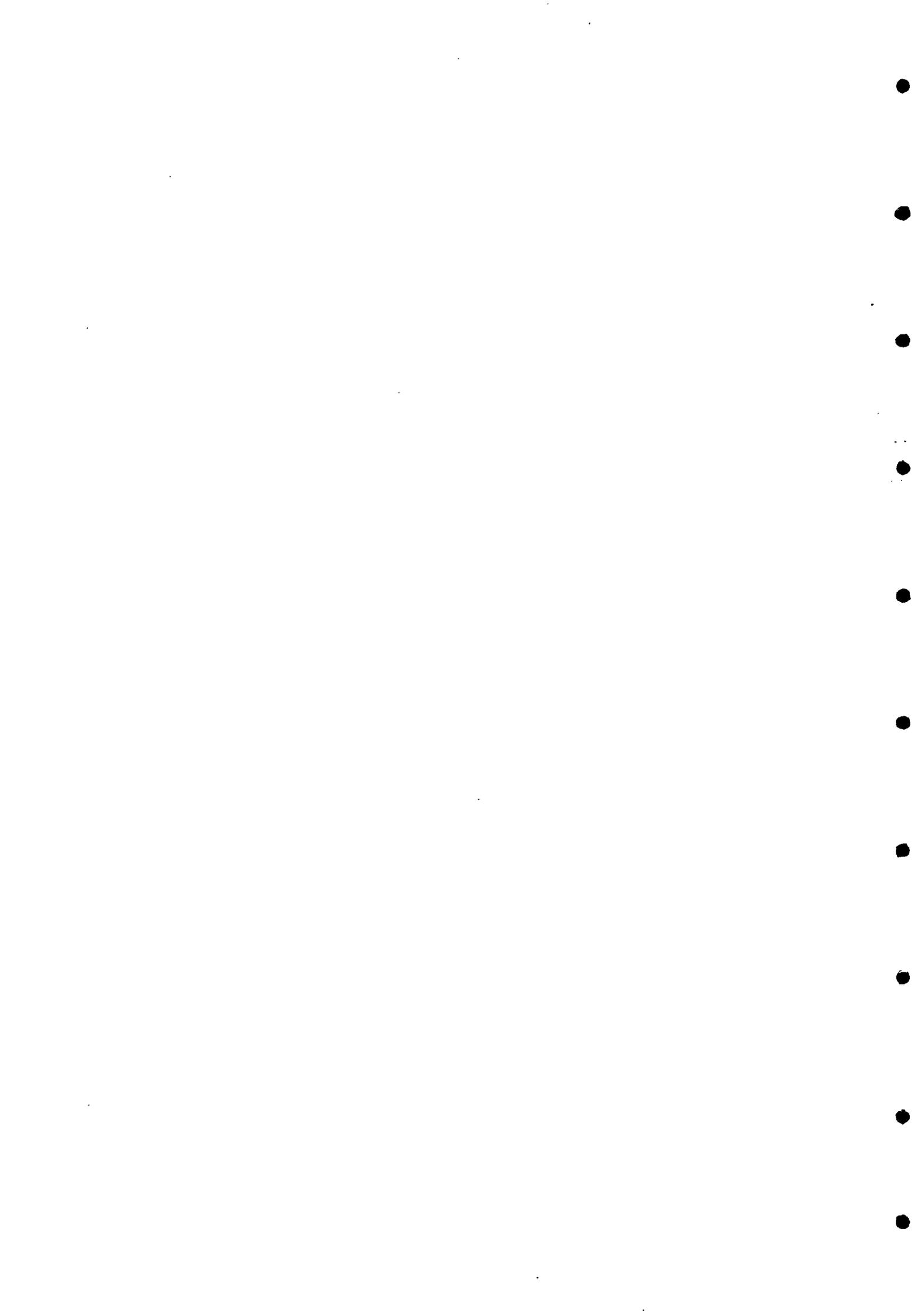
The foregoing demonstrates that P-E relationships are very complex and multifactorial in African communities. Understanding them, therefore, requires detailed, painstaking investigation of the numerous factors, linkages and processes operating in such communities. Hence a local-community approach provides the opportunity for unravelling the intricacies involved. It also holds out immense prospects for designing practical solutions to the P-E related problems.

The phases model enables us to classify the local communities, ecological units or population groups according to their dominant characteristics and indicators of P-E situation, harmony or disharmony; development and welfare status; or according to their P-E related crises and intervention efforts. This is because the communities, rural or urban, are not homogeneous in their P-E experiences, factors or phase of the process, the imbalance or the intensity of the crises. Indeed, some communities experience more P-E imbalance and disharmony than others.

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**PART III**

**MORTALITY AND HEALTH IN URBAN AND INDUSTRIALIZED  
ENVIRONMENTS**



## CHAPTER 15

# MORTALITY AND THE ENVIRONMENT: OBSERVATIONS ON THE GEOGRAPHY OF MORTALITY

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More than other researchers in the social sciences, geographers are accustomed to environmental approaches and are aware of environmental issues. Among population geographers, however, few have studied the relationship between population and the environment. Since the early seventies, population geographers have drawn nearer to demographers and have tended to study the spatial variations of demographic phenomena. This position is quite clear in recent books of population geography or in atlases devoted to the population. It is equally clear in studies undertaken by the Commission on Population Geography which operates within the International Geographical Union; over the last ten years, this Commission has tended towards demographic themes.

The relationship between population and the environment has not however been entirely put aside. The study of this relationship was approached during certain meetings of the Commission, notably during the symposium held in Lille, France, in 1990, which was dedicated to the geographical inequalities of mortality. This symposium attracted 130 researchers from many countries and gave rise to 80 papers which were published in three separate documents between 1990 and 1993 ("Les inégalités géographiques...", 1990-1; "L'inégalité devant la mort...", 1991; "Geographical Inequalities...", 1993). In creating new topics moreover, the symposium stimulated research in the geography of mortality during the following years. A certain number of studies which looked entirely or partially at the relationship between mortality and the environment during and after the meeting are referred to in this paper in order to assess and review the subject so far.

### 1. Methodological Problems

The study of the relationship between mortality and the environment is not easy whatever the type of mortality considered.

- 1) In the case of natural disasters, the link to the environment is perfectly clear, but the total number of human losses is often uncertain. This is the case for various brutal phenomena such as earthquakes, volcanic eruptions, hurricanes, floods, avalanches and landslides.

A count of the total number of victims is not too difficult when a small-scale or medium-scale disaster is considered and when the number of people dead or

missing can be counted in units, tens or even in hundreds. In the case of a large-scale disaster which causes the loss of thousands of people, tens of thousands or sometimes hundreds of thousands, this operation is very uncertain as most bodies are not found. Moreover, these terrible disasters normally strike the developing countries of the world where population statistics are poor and where the administrative framework is weak. For instance in Bangladesh, when an appalling cyclone and a huge tidal wave inundated part of the delta in 1970, the official figure was 242,000 victims whereas, in later weeks, experts estimated the total between 300,000 and 400,000 (Paucton, 1992).

- 2) The relationship between mortality and the physical environment is less clear in the case of certain exceptional climatic phenomena which are less brutal.

So the statistics for heat waves and cold spells, which can sometimes provoke not insignificant loss of life, are lacking in most countries. This is also the case for long droughts which continue to provoke large-scale disasters in developing countries. The cost in human lives may be considerable; in the great famine of China in 1877-8, which was due to an exceptional drought, 9 to 13 million people are thought to have died (Curson, in Clarke, 1989). In Ethiopia, drought-linked famines are believed to have caused the death of 2 to 5 million people during the sixties and seventies (Mesfin, 1984). It must be emphasized however that these estimations are highly uncertain, and that it is impossible to distinguish in these disasters between the results of the drought itself and the results brought about by other factors. The causes of these disasters are very complex and not only physical.

- 3) In the case of "ordinary" mortality, i.e. disasters being excluded, the link with the environment is always difficult to ascertain, even where statistical data on mortality is precise and where information exists on the environment.

Most causes of death are in fact linked not to one sole factor, but to a group of factors, and it is difficult to distinguish between one environmental factor and another. To form correct hypotheses, mortality must be analyzed by sex, age and cause of death. But the more the subject is analyzed, the more it is difficult to undertake a detailed geographical analysis as the number of deaths becomes few for one particular cause of death in one particular small area. Even when the statistics for three or five, or even seven years, are taken into account (the year of census and those surrounding it), the risk of random results cannot be excluded (Noin, in "Les inégalités géographiques...", 1990-1).

Moreover, mortality statistics by place of residence are complicated by the fact that the cause of death may be due to an aggressive environment which is far away from home, or linked to a former place of residence. In the case of cancer particularly, there may be a big difference in time between the exposure to a risk factor, and the death.

## 2. Natural Disasters and Mortality

The human cost of natural disasters will be examined first, as in spite of the uncertainty of statistical data, this is the best known point. Quite a lot of publications exist on the subject, in which several geographers have attempted an assessment (Foucher, 1982;

Thomson, 1982; Clarke, 1989; Noin, 1994). In 1991, research studies were encouraged by the International Geographical Union (I.G.U.) and by the Commission on Population Geography (Paucton, 1992). These were based on data from reinsurance companies, in particular the Compagnie Suisse de Réassurances, Zürich, and the Münchener Rückversicherungs Gesellschaft, München ; they are as exhaustive as possible for the period 1970–90. In this research, it is considered that a climatic accident or an earth tremor becomes a disaster when the number of victims is 20 or above. Only violent phenomena relating to the physical environment are considered. Heat waves, cold spells and periods of exceptional drought are excluded for the reasons stated above. A brief review of this research follows.

During the period 1970–90, disasters of telluric origin resulted in a total of almost one million victims: 943,000 for seismic phenomena (earthquakes and tsunamis) and 24,000 for volcanic eruptions; 91 earthquakes and 7 eruptions were recorded as disasters given the definition adopted above. These two groups of phenomena are connected since they are both linked to the movement of tectonic plates of the earth's crust; they nearly always occur at the limits of these plates. However, the geographical distribution of victims is different. The most fatal earthquakes occur principally in Asia where plate movements are most evident and where the population is very dense (Fig. 1). Destructive volcanic eruptions primarily affect the Americas, especially the American isthmus, the West Indies and the Andes (Fig. 2).

Still considering the same period 1970–90, disasters of atmospheric origin gave rise to over 650,000 victims: 604,000 due to hurricanes, cyclones, storms, tornadoes and other violent atmospheric phenomena, and 54,000 to floods. The distinction between these two types of disasters is very uncertain as many more people die by drowning during hurricanes than because of violent winds. There were 564 disasters of atmospheric origin within the period 1970–90, 365 considered as hurricanes or cyclones and 199 as floods. South and South–East Asia were undeniably the worst hit areas, being a zone of high hurricane risk due to a strong contrast of air masses several times each year (Figs. 3 and 4). Besides hurricanes and floods, landslides which are often caused by torrential rain took 6,500 lives in 1970–90, and avalanches caused by abundant snowfall took over 1,000 (Figs. 5 and 6).

In total over this period, 740 disasters of all kinds caused over 1.6 million victims. The number of disasters and particularly the number of victims has increased from the first decade to the second. This increase may be partly due to better recording but, more importantly, it seems linked to population growth. Asia is by far the worst hit area of the planet, counting 84 per cent of the deaths. Countries with the highest number of victims are all Asiatic: China, Bangladesh, India and Iran rank highest in the table; then comes Japan far behind.

Mortality linked to disasters affects particularly the poor countries : during the years 1970–90, 92 per cent of the victims were recorded in the developing countries which represented 74 per cent of the world population. This high proportion can be explained by a set of reasons: high densities in the worst affected Asiatic countries, high proportion of urban population in these same countries, and development of the habitation of the poor in dangerous areas which are not suitable for building (flood plains in particular, steep slopes and ravines). Developed countries are also affected by natural disasters (Japan, California, South–Eastern States of the U.S.A.), but there are fewer and fewer victims due to various safety measures such as anti–seismic

norms for construction, dams against overflows, hurricane warnings, surveillance of dangerous volcanoes and evacuation procedures in case of danger.

Though these results are of great interest, it must be emphasized that a period of 21 years is a little short for an in-depth study of the phenomena, given its extreme annual variability. It is possible to go further back in time, though the data become less numerous and reliable the further back you go. An evaluation for a longer period, from 1900 to 1990 was attempted (Paucton, 1992) giving a total of 7 million victims due to natural disasters. The geographical distribution was very similar for the various types of phenomena (Fig. 7). The proportions concerning Asia and the poor countries as a whole were very similar for the years 1900–90 compared to the period 1970–90. The only difference was the proportion of victims due to the various types of disasters. There was a greater proportion of victims due to disasters of atmospheric origin, as China was severely affected by terrible floods on several occasions with very high loss of life (4 million victims in total during those years).

### **3. The Environment and Ordinary Mortality**

The role of the environment on ordinary mortality, i.e. not caused by disasters, is less obvious and is often very difficult to determine.

The studies presented at or consequent to the Symposium of Lille were contradictory on this point. In fact, the importance given to the environment was very different among the researchers having undertaken studies on the subject.

- 1) Certain authors consider that the environment in some cases holds some responsibility in mortality. Among these authors, it is not surprising to find several geographers from Eastern Europe where the degradation of the environment in certain regions was truly catastrophic during the seventies and eighties. Several Polish authors emphasized this deterioration and its consequences for Poland as a whole (Pulaska-Turyna, 1991; Potrykowska, 1991) or for a particular region (Miszewska, 1990 on lower Silesia). According to Pulaska, the pollution of the air, the rivers and the soils is well over the limits considered as dangerous. The most affected areas are the South and the West : on the one hand, mining and industrial towns and, on the other hand, rural areas of large state farms using massive quantities of chemical products. This author attributes the high cancer mortality of the Western regions to pollution, as well as the increase in male adult mortality and male excess mortality since the sixties. Potrykowska arrives at roughly the same conclusion using elaborate statistical methods. She observes that seven to nine-tenths of deaths due to tumours are statistically associated to environmental factors in Poland. She links cancer mortality with the pollution observed in industrial towns and in the countryside. More important than the role of fertilizers and pesticides, she blames the water distribution network which is insufficiently purified and which contains harmful chemical and metallic elements. She maintains that the link between ecologically degraded areas and zones of high cancer mortality is undeniable.

None of the West European authors is as certain. In the west of the continent, some deaths are indeed linked to the environment but in a limited measure or for very specific causes. This is so, for instance, in the Nord-Pas-de-Calais region

in France (Lacoste *et al.*, 1990:91). At the beginning of the eighties, a clear excess mortality was still observed in the mining area due to respiratory diseases and especially silicosis (or pneumoconiosis) as the extracted coal was particularly rich in silica dust which was harmful to mine workers' lungs (Fig. 8). It must nevertheless be noted that this is mainly a phenomenon of the past, since mining activity practically ceased in the eighties and the last pit closed in 1990. Other activities derived from coal also stopped and the pollution level was considerably reduced. There is a time-lag effect however, as the disease continues to develop in the affected men who now represent essentially the older generation.

- 2) Most of the authors who worked on the geography of mortality for the Lille symposium or in its wake consider that the environment is a minor or insignificant factor in mortality. For them, the important factors are economic, social or cultural. In the more developed countries, geographical variations of mortality are not linked to ecological factors, but to the level of education, to the use of health facilities, to the diet adopted and to certain harmful habits such as cigarette smoking and alcohol drinking. In fact, mortality maps of Europe show no relationship to industrial areas (Decroly and Vanlaer 1991). It is a similar picture for detailed studies carried out in various European countries (Cohen, 1991 for Spain; Decroly and Grimmeau, 1991 for Belgium; Kemper and Thieme, 1991 for Germany; Kunst *et al.*, 1991 for the Netherlands; Meneghel, 1991 for Italy; Tonnelier, 1991 for France). Moreover, some studies undertaken in Eastern Europe do not show up this relationship either, for instance for former Czechoslovakia (Rychtariková and Dzurová, 1991).

If instead of looking at total mortality, analysis is directed towards one specific cause of death or another, it is not environmental factors which emerge, but national and regional behaviour patterns (Lange, 1991). For lung cancer, it is particularly the relationship with the smoking habits of the population over many preceding years, perhaps twenty years or so, which is the main causal factor (Fig. 9). For cancer of the *œ*sophagus, it is especially the consumption of alcohol over many preceding years (Fig. 10). The differences between the sexes clearly emphasize the essential role of behaviour patterns. For the consumption of cigarettes, the worst affected areas are appreciably different for men and for women. For the consumption of alcoholic drinks, they are very different.

#### 4. Conclusions

These few observations on the geography of mortality are not exhaustive of a subject which is vast and complex. Many questions are left without answers. More research is necessary on various countries, using detailed geographical analysis and investigations in the aetiology of diseases causing death. Nevertheless, some provisional conclusions can be put forward.

- 1) For the exceptional mortality caused by disasters, the physical environment is clearly at fault, although it is far from being the only factor involved. The appalling number of victims which is occasionally experienced in poor countries is largely due to the installation of numerous populations in risk zones and to the absence or quasi-absence of protective measures. Some ripostes are possible. In the

United States for example, mortality due to hurricanes is constantly diminishing (about 700 people killed in the twenties, 50 in the eighties). However an efficient response in the developing countries will require a great deal of time and money.

The impressive estimations established also require relative comparison. For the period 1970–90, victims due to natural disasters amounted to roughly 0.16 per cent of the total number of estimated deaths, that is to say a minute fraction of the whole. Even in the worst affected countries, this exceptional mortality represented a very small share of the total mortality: 1.6 per cent in Bangladesh (ten times the world average), 0.5 per cent in China (three times the world average).

- 2) When ordinary mortality is considered, here again the role of the environment appears to be very small on the whole. In West European countries, the environment is probably at the origin of deaths caused by exposure to aggressive elements, but globally its part in mortality is negligible. In East European countries, the alarming degradation of the environment which is sometimes observed could no doubt explain a stronger influence, especially for deaths due to cancer and respiratory diseases. This link nevertheless requires confirmation through detailed studies in demography, geography and epidemiology. In these countries, the considerable influence of the living conditions, health facilities, dietary habits, cigarette addiction and alcoholism do not seem to have been taken sufficiently into account.

Until complementary research brings more clarification, it would seem wise in general not to overestimate the role of the environment on mortality.

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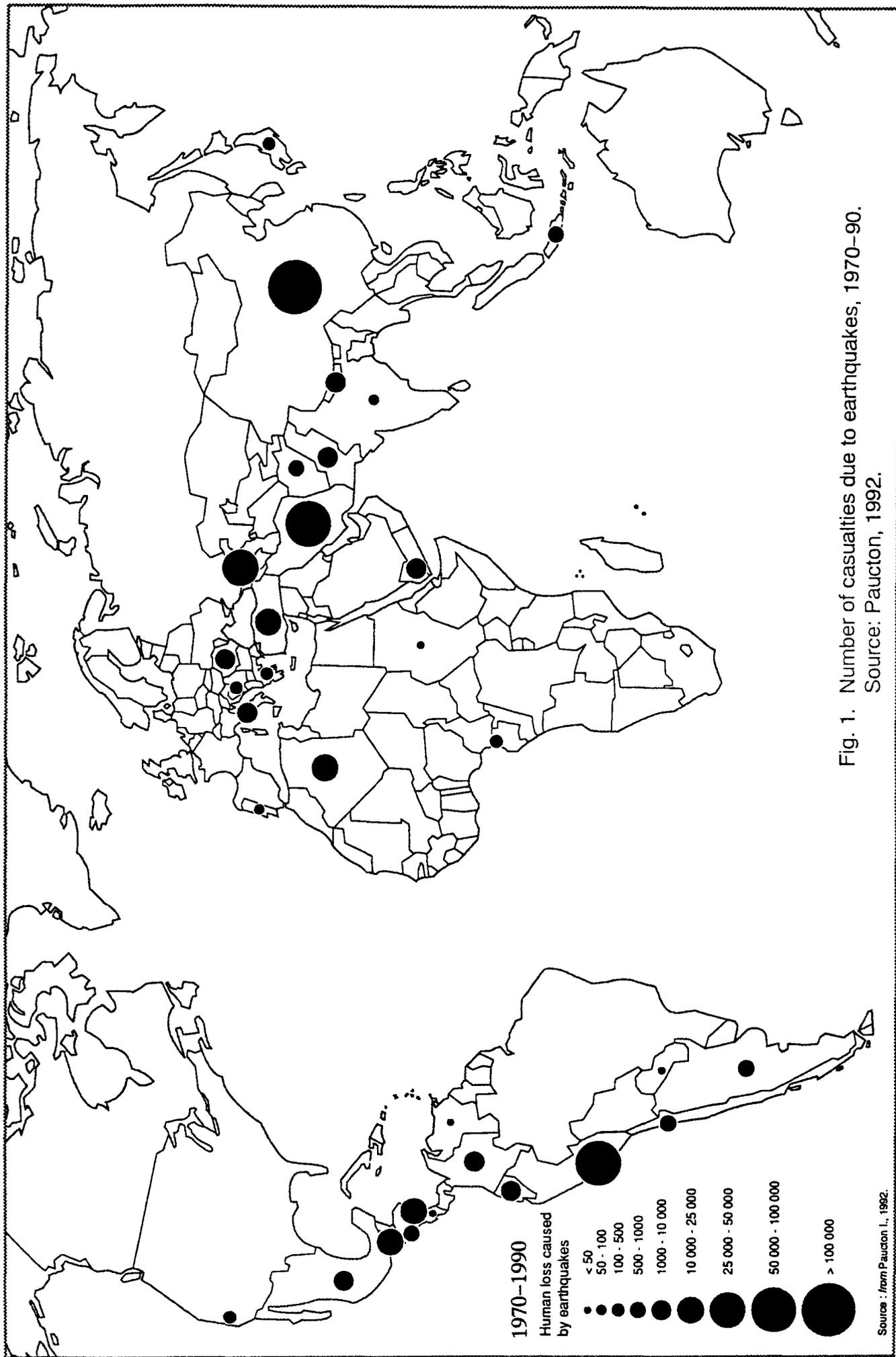


Fig. 1. Number of casualties due to earthquakes, 1970-90.  
Source: Paucot, 1992.

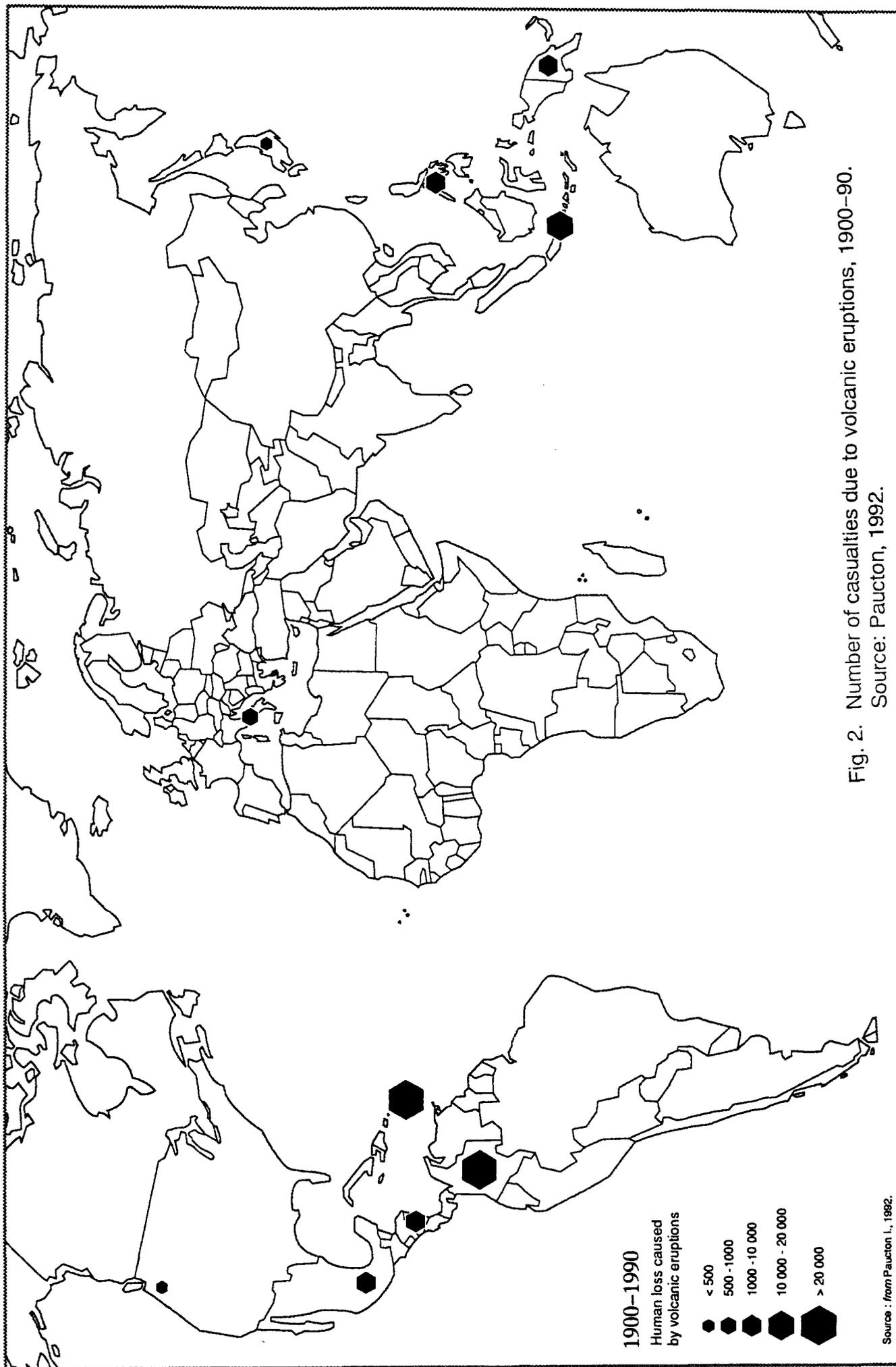


Fig. 2. Number of casualties due to volcanic eruptions, 1900-90.  
Source: Paucton, 1992.

Source : from Paucton I., 1992.

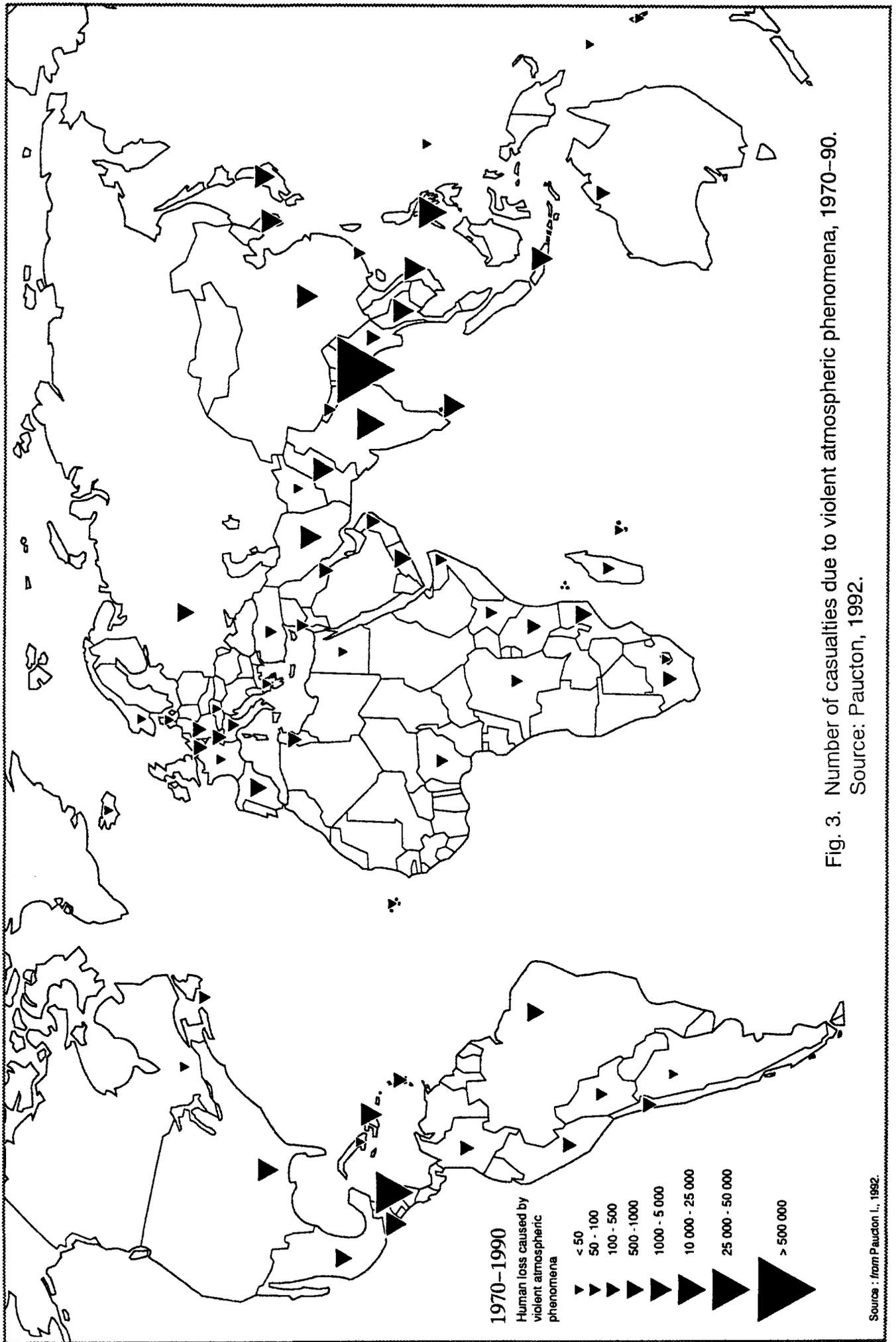


Fig. 3. Number of casualties due to violent atmospheric phenomena, 1970-90.  
Source: Pauton, 1992.

Source : from Pauton I., 1992.

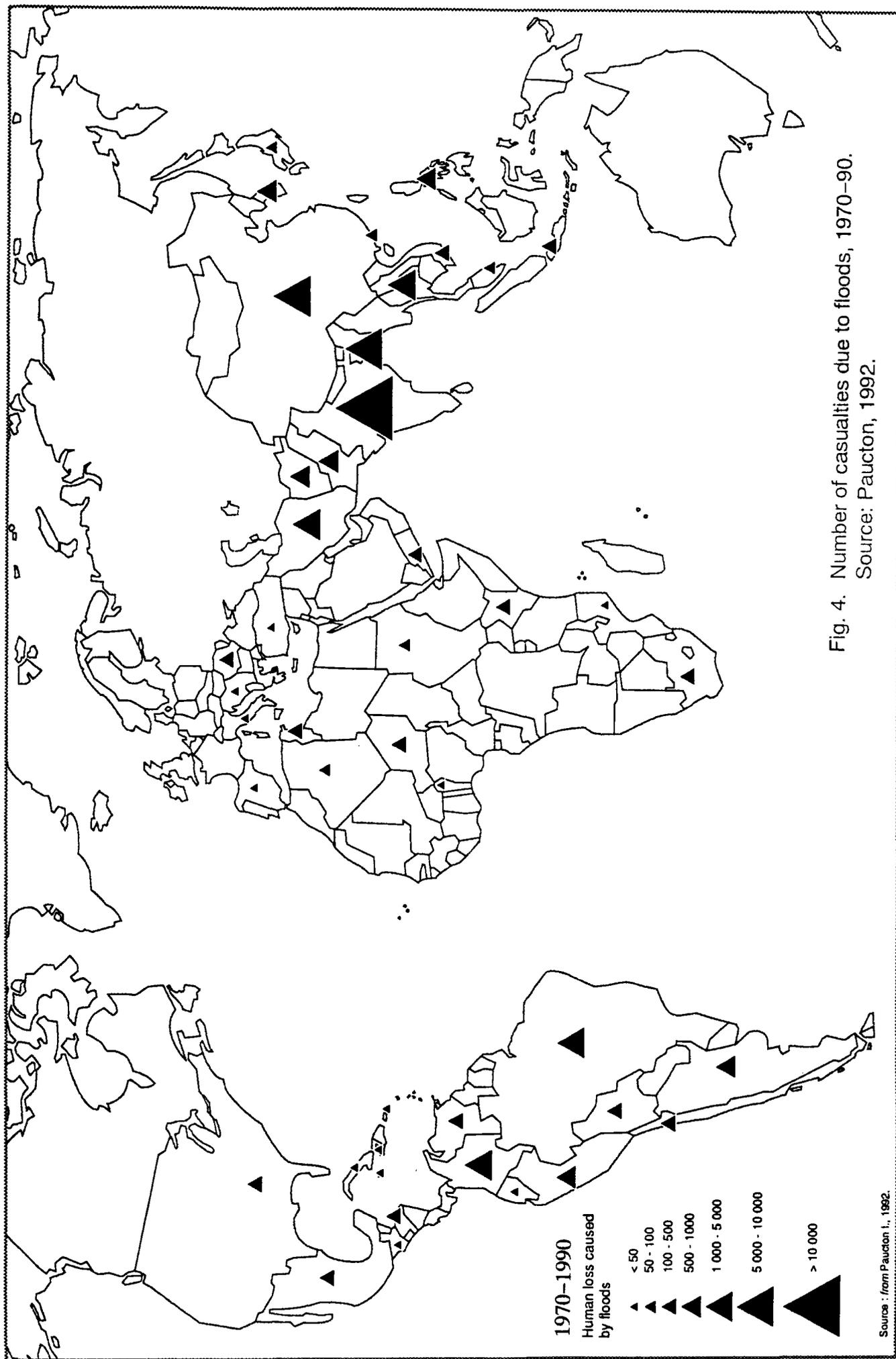


Fig. 4. Number of casualties due to floods, 1970-90.  
Source: Pauton, 1992.

Source : from Pauton I., 1992.

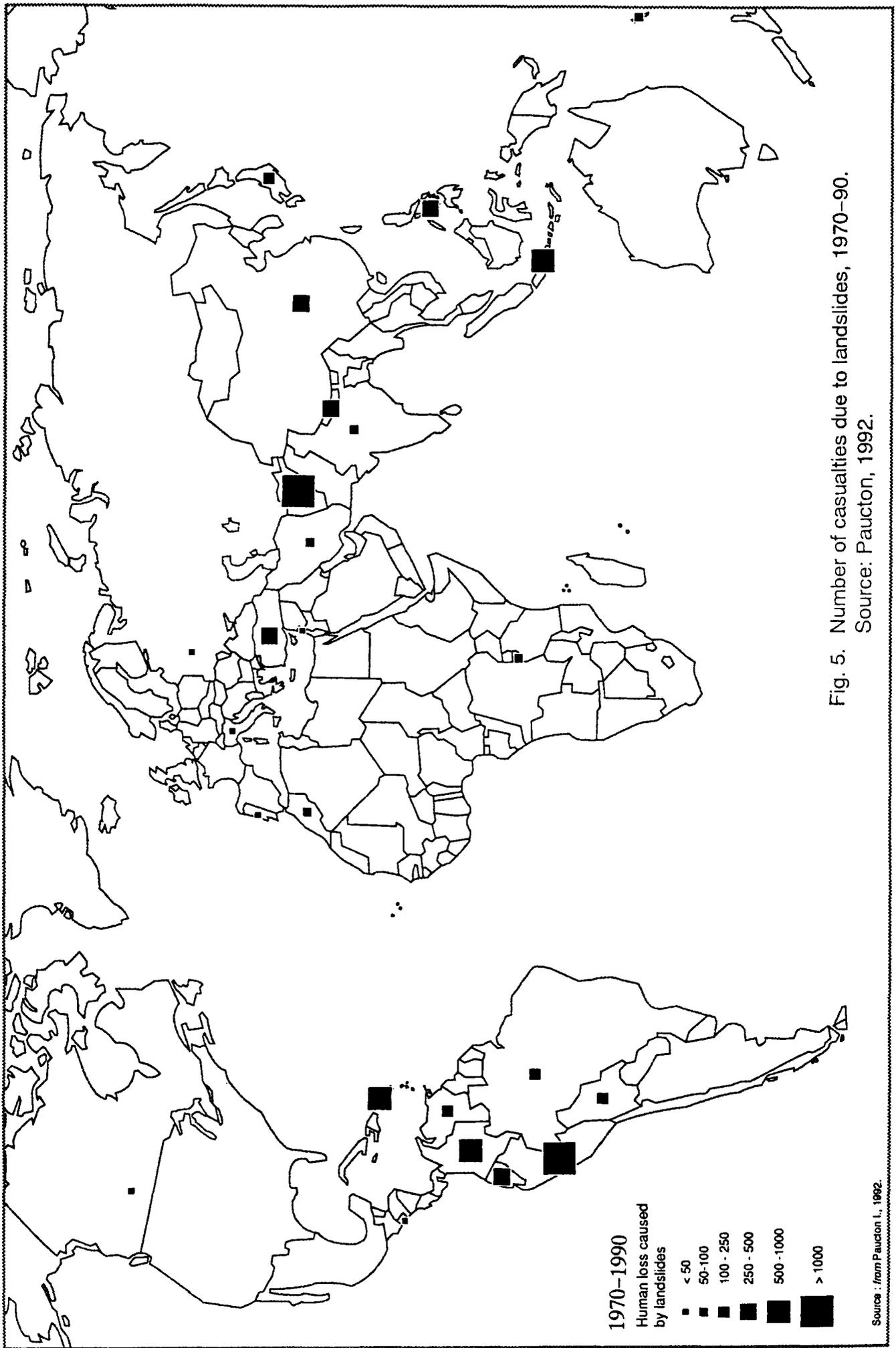


Fig. 5. Number of casualties due to landslides, 1970-90.  
Source: Pauton, 1992.

Source : from Pauton I., 1992.

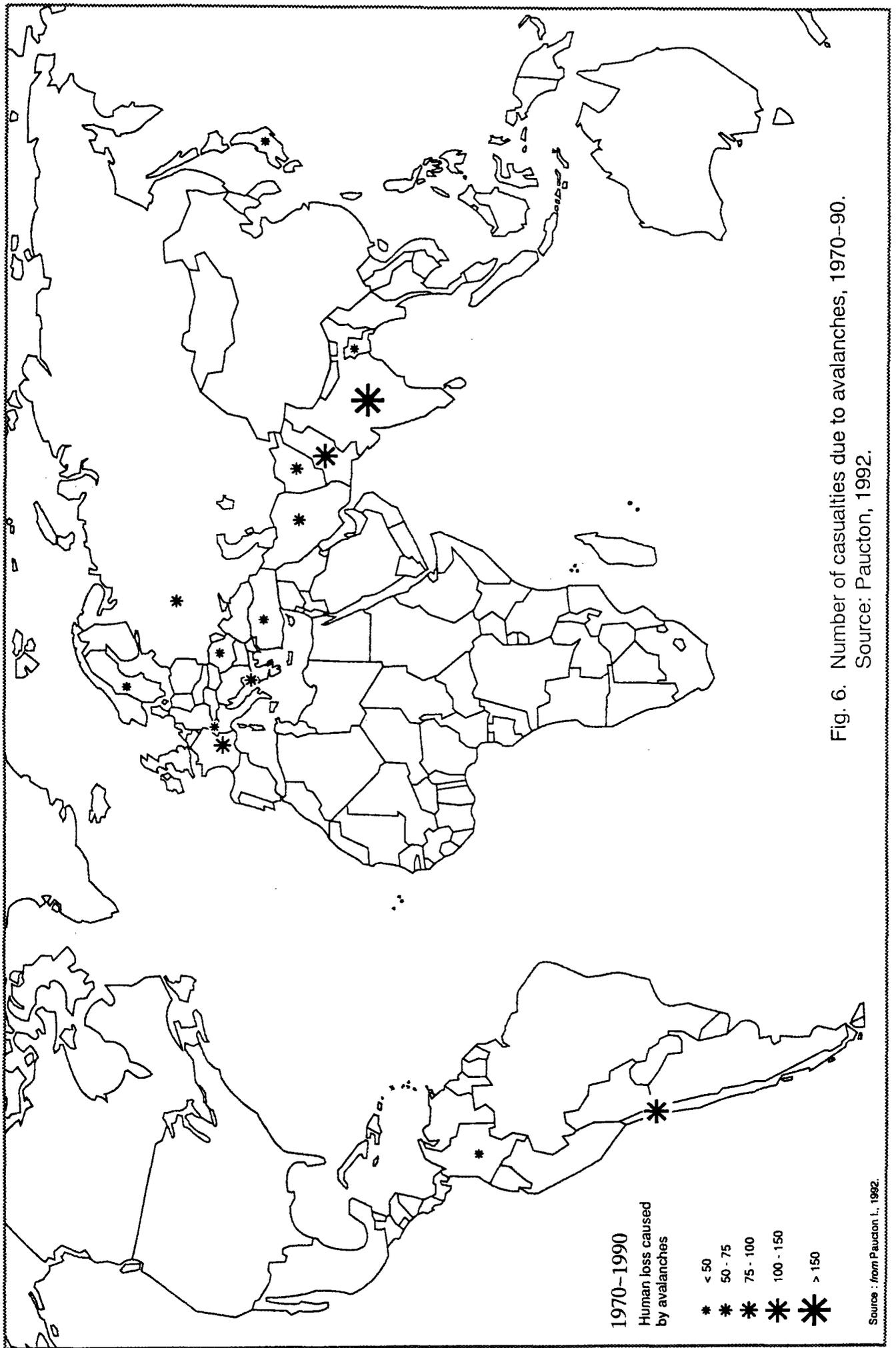


Fig. 6. Number of casualties due to avalanches, 1970-90.  
Source: Pauton, 1992.

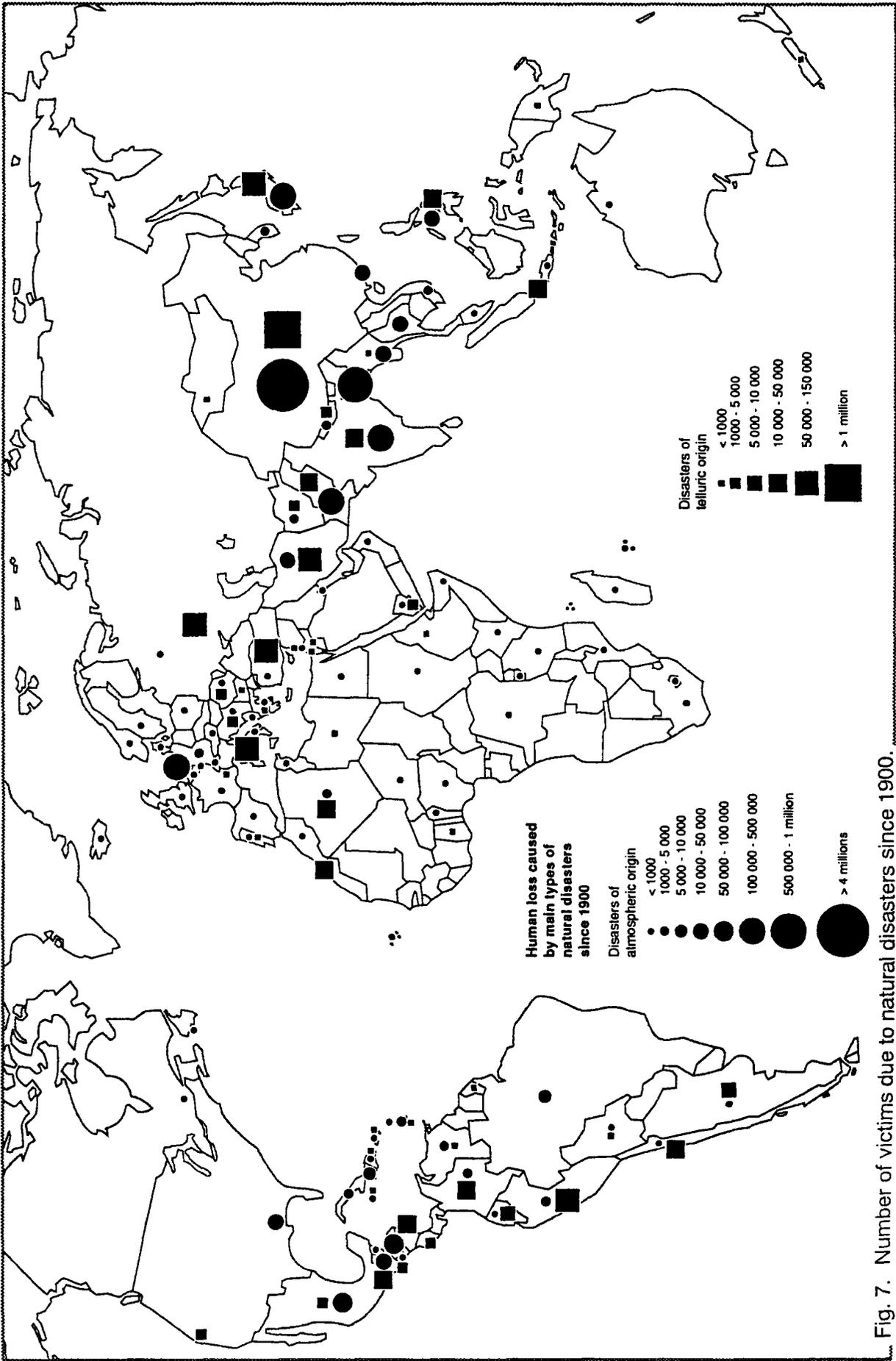
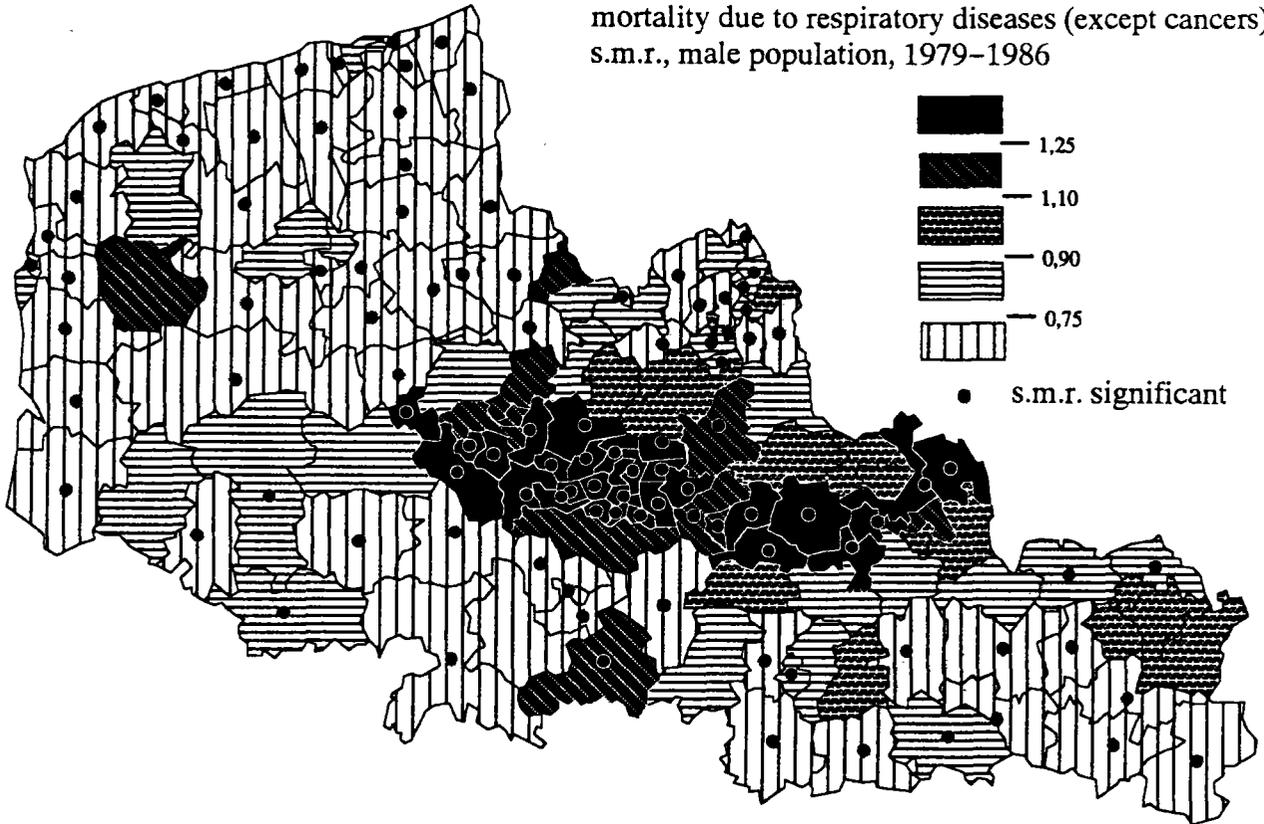


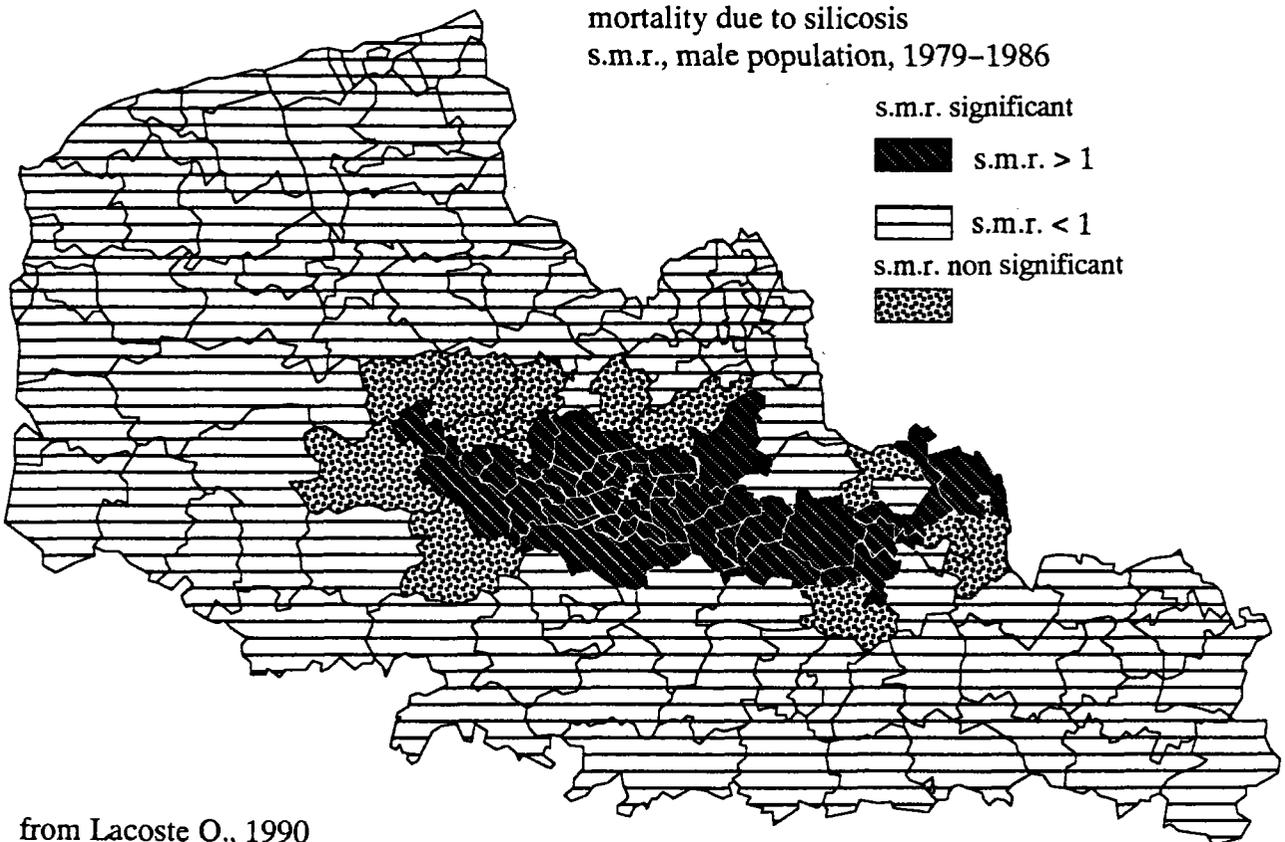
Fig. 7. Number of victims due to natural disasters since 1900.  
Source: Paucton, 1992.

Fig. 8.

Nord-Pas-de-Calais region, France  
mortality due to respiratory diseases (except cancers)  
s.m.r., male population, 1979-1986

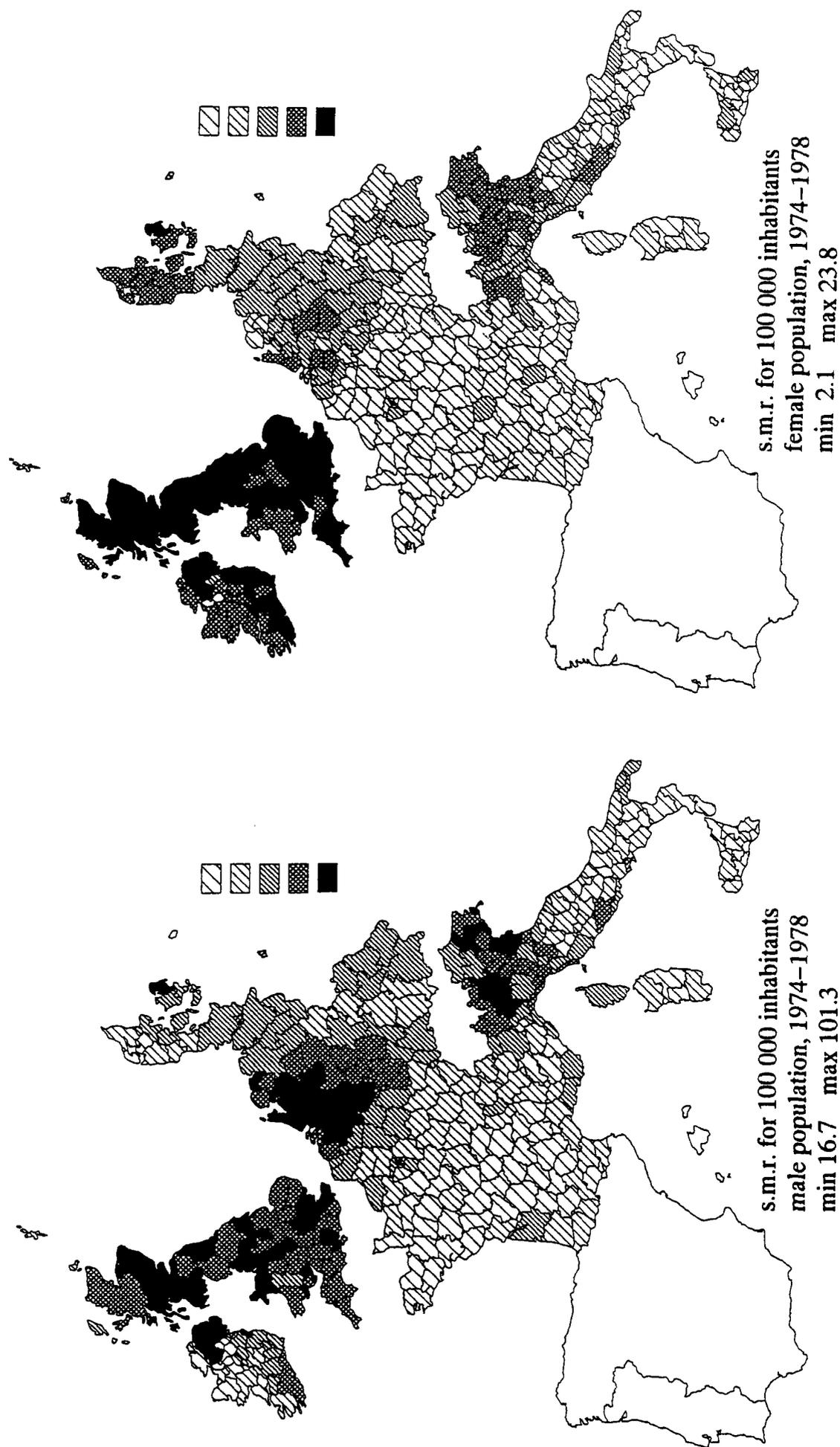


Nord-Pas-de-Calais region, France  
mortality due to silicosis  
s.m.r., male population, 1979-1986



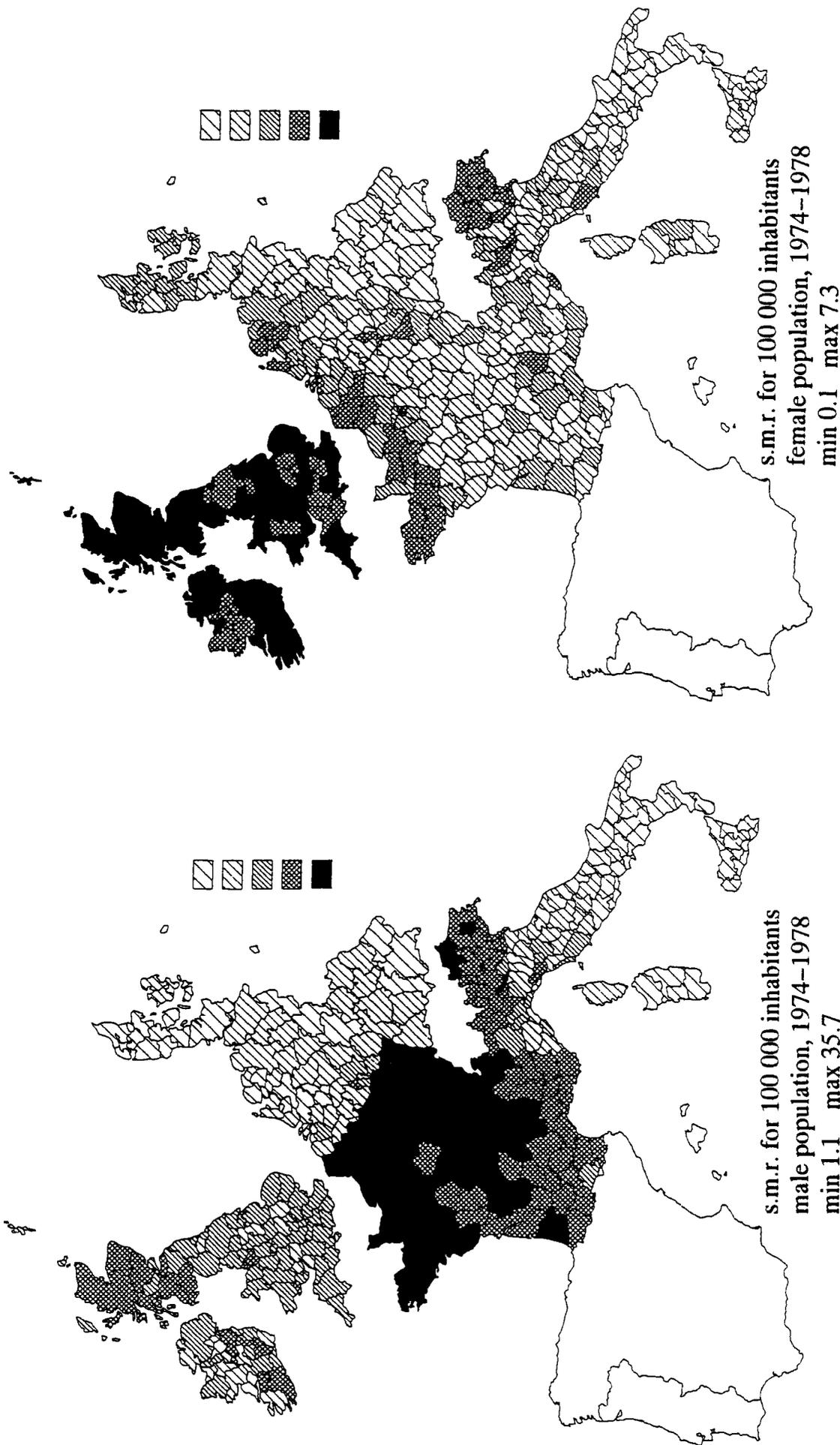
from Lacoste O., 1990

Fig. 9. Standardized mortality rate from lung cancer for (a) males and (b) females in several European countries, 1974-78.



from Lange I., 1992

Fig. 10. Standardized mortality rate from cancer of the oesophagus for (a) males and (b) females in several European countries, 1974-78.



from Lange I., 1992



## CHAPTER 16

# THE EFFECTS OF THE ENVIRONMENTAL POLLUTION FOR POPULATION IN POLAND

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### 1. Introduction

Poland, a country confronted with ecological disaster, faces the very difficult task of reshaping its environmental policy during a time of radical change in the national economic system. This new policy moves from what was once a narrow understanding of environmental protection to a broader goal of sustainable development, i.e. the attainment of a balance between social, economic, technical and environmental conditions in the process of development. This kind of understanding for the idea of sustainable development should be beneficial to addressing society's social and economic needs.

"The policy of sustainable development will be implemented through the enforcement of environmental requirements in every public and economic activity throughout the country, as well as through an appropriate policy towards neighbouring states. The consciousness of each citizen's sense of individual responsibility regarding environmental protection in all aspects of life, at home, work or play, must be raised. Under the changing conditions of the economic and political system it is necessary to incorporate the principles of sustainable development into the newly developed legal and economic framework as well as into the new management system. The process of economic reconstruction, now underway, shall, in addition to social and economic goals, take into account environmental goals. An effective policy of sustainable development should embrace all sectors of the economy." (National Environmental Policy of Poland, 1991).

These are the directions by which environmental pollution is to be counteracted and a policy of sustainable development put into practice. Emissions of particulates, gases, sewage, saline waters and wastes are to be limited, as is the degradation of soil. This requires a fundamental reconstruction of the country's economy; particularly in those sectors which pose a particular threat to the environment, i.e. power supply and the extraction of energy resources. It will also require a rationalization of industry and transport. These priorities will first embrace the areas now considered to be ecological disaster areas, i.e. those in which standards for air, soil, and water quality are exceeded to a considerable degree hazardous for human health. This means that comprehensive environmental policies must be developed, and effective methods for implementing them must be established as soon as possible. Many Western and

Polish organizations as well as scientific institutions and academic bodies are actively involved in this process.

The Institute of Geography and Spatial Organization, Polish Academy of Sciences and other scientific centres have a strong interest in carrying out research on Population and Environment (P-E) in Poland. The main areas of research activity in the field of P-E studies may be summarized in six groups of issues as follows:

- 1) Methodological research;
- 2) Population and Environmental data issues<sup>1</sup>;
- 3) Population concentration and deconcentration<sup>2</sup>;
- 4) Identification and analysis of P-E crisis areas;
- 5) Population-environment relationships in settlement systems;
- 6) Comparative P-E studies on the international and national policy<sup>3</sup>.

## **2. Methodological Research**

Studies on environment transformation in Poland under the influence of human economic activity with special attention paid to areas under urbanization pressure are being conducted by A. Brey Meyer. The main research topics are: the theory and methodology of the study on mutual influence of human economy and nature research on mechanisms controlling ecological units at different levels of organization; establishing, evaluation and verification of methods for studying the man-environment interactions, with special attention paid to bioindication, economic and systems analysis methods; comparative studies of land ecosystems in different climatic conditions with the application of transect method; research on air pollution influence on ecosystems; development of methods for evaluation of ecological (production and destruction of organic matter) and geomorphological (organic matter washout) processes influencing organic matter budget in ecosystems.

Collaboration within the framework of international research programmes includes those sponsored by the International Council of Scientific Unions (ICSU) such as SCOPE (Brey Meyer, 1993).

The programme of studies on Global Environmental Change is going to develop under the direction of L. Starkel, head of the Department of Geomorphology and Hydrology of Mountains and Uplands (Cracow). This is a grant programme sponsored by the National Committee for Scientific Research and its main research topics are studies on evolution of land forms and water circulation in mountains and uplands as connected with changes of climate and human activity.

### **3. Identification and Analysis of Population–Environment Crisis Areas (the analysis and synthesized map of natural environment and environmental pollution of Poland)**

The idea for the publication of the atlas of Polish natural environment emerged at the beginning of the 1970s. A leading role in its conception and formation was played by S. Leszczycki, former director of the Institute. *The Atlas of Resources, Values and Degradation of Poland's Geographic Environment* (1993) is the first of our publications presenting an integrated, synthetic approach to the basic problems. It contains a wealth of information, both in terms of quality and quantity, about the natural features of the environment, its qualities and resources, its state, and the scope and directions of its change. Particular attention is paid to the issues of nature conservation, to phenomena associated with human activity which puts the natural environment at risk, and to the evolution of the various qualities and uses of the environment. It is a most comprehensive spatially-oriented documentation of those phenomena and processes which make up the qualities of the Polish natural environment.

The analysis of the state of individual elements of the environment, supplemented with information on hazardous environmental pollution made it possible to carry out spatial differentiation of the phenomenon, and consequently 27 areas were distinguished in which the state of natural environment was recognized as particularly hazardous for ecological balance or human health (Fig. 1). These 27 areas of ecological hazard in Poland, feature a total break in the state of natural balance manifested by a loss of resistance, elimination of the self-regeneration processes, and degeneration of the biosystems, as well as intensified health hazards and incidence of diseases conditioned by the state of the environment. These areas are situated in the main regions of concentration of mining and metallurgy in the South: Upper Silesian District, Cracow Region, and Legnica–Glogow Copper Basin in Lower Silesia (the biggest and most onerous sources of environment pollution with chiefly wastes, dust, gases and sewage), and in the remaining urban agglomerations (Warsaw, Lodz, Poznan, Wroclaw), especially the two northern seaports of Gdansk and Szczecin (where the hazardous state of the natural environment has international implications because of their localization on the Baltic coast).

Within the 27 ecologically endangered areas encompassing altogether 11.2 per cent of the country's surface, where more than 10 million people live (i.e. 35.4 per cent of Poland's population), and where there are especially high levels of toxic elements, soil, air and water pollution, the limits of ecological resistance of the natural environment have been violated to such an extent that the health of the inhabitants is threatened.

Sometimes the safety limits for some of these elements are exceeded so drastically that it causes mass poisoning as, for example, the lead poisoning of children in Szopienice (The Upper Silesian Industrial District) in the late seventies. It is insufficient to discuss the risk of exposure to toxic elements solely on the basis of reports on their amounts in air, soil or water because many of them circulate via the alimentary chain. This way the elements travel from soil water to plants and animals, and finally reach human organisms exposing them to toxic elements in human tissues. I. Baranowska *et al.* (1992) have confirmed such concentration of heavy metals in human tissues. Lead, cadmium, zinc, manganese, chromium, cobalt, copper, and molybdenum concentration

were measured in 50 samples of placenta tissues from Tychy in the Upper Silesian Industrial District, where the population is exposed to enormously increased levels of heavy metals. Mean concentrations of metals in the placenta were determined. Coexistence of increased levels of various metals was checked. The concentration of heavy metals in the samples coming from the polluted industrial territory is much higher than in those collected in cleaner regions. In the Upper Silesian Industrial District, where the concentration of heavy metals in the environment is extremely high, this kind of research had not been conducted before.

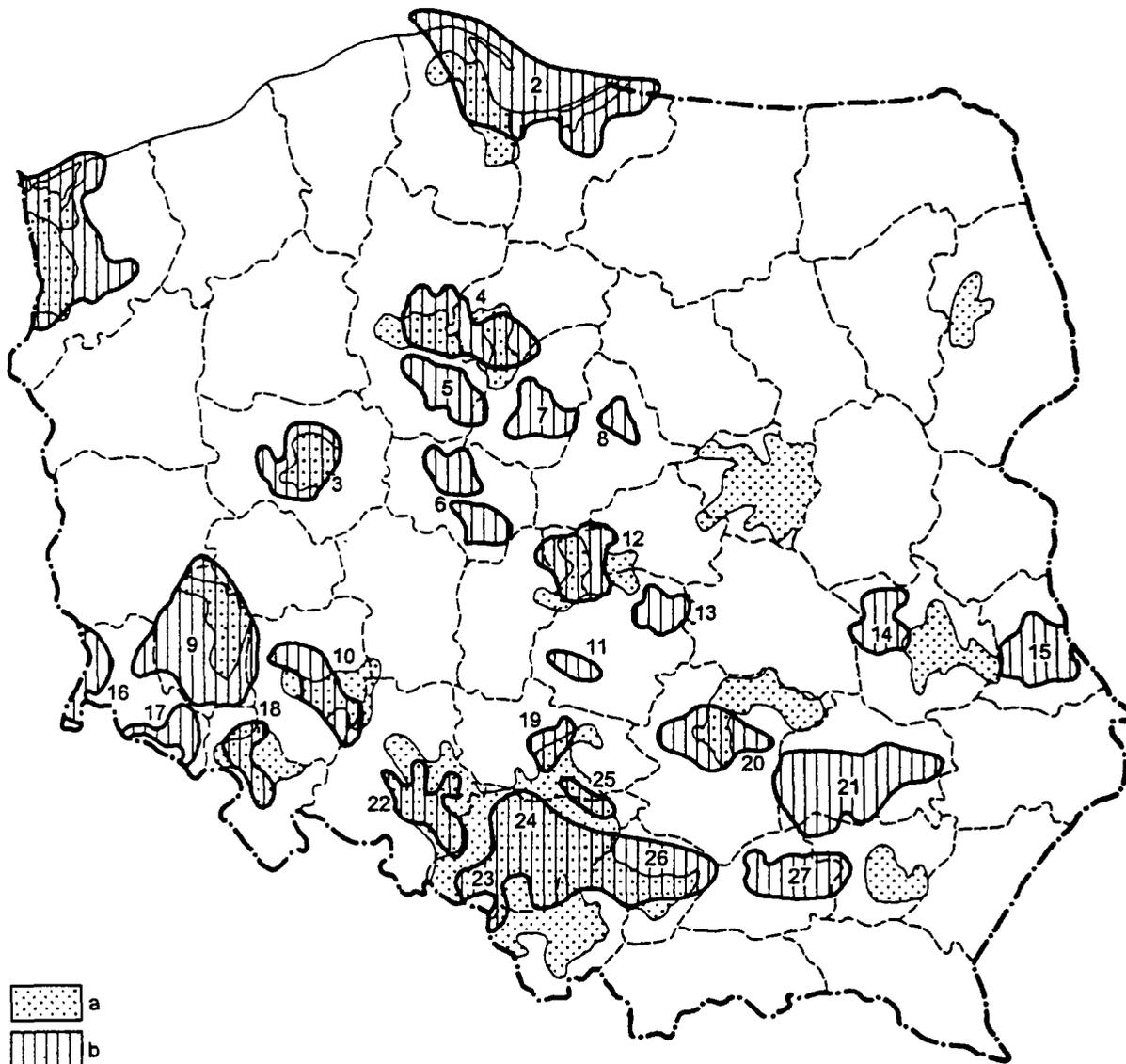


Figure 1. Hazardous environment pollution in Poland

a. Urban agglomerations

b. Areas of ecological hazard:

- 1- Szczecin, 2- Gdansk, 3 - Poznan, 4--Bydgoszcz-Torun, 5- Inowroclaw, 6- Konin, 7- Wloclawek, 8- Plock, 9- Legnica-Glogow, 10- Wroclaw, 11- Belchatow, 12- Lodz, 13- Tomaszow Mazowiecki, 14 -Pulawy, 15- Chelm, 16- Turoszow, 17- Jelenia Gora, 18- Walbrzych, 19-Czestochowa, 20- Kielce, 21- Tarnobrzeg, 22- Opole, 23-Rybnik, 24- Katowice, 25- Myszkow -Zawiercie, 26- Cracow, 27- Tarnow.

Source: Cz.Rolewicz, 1993.

#### **4. Population–Environment Relationships in Settlement Systems**

The research topics conducted by geographers and demographers are: studies of impact of the environmental degradation and the changes in the local rural settlement system; migration change; environment and the settlement system in Poland; the urban settlement system: the population in heavily industrialized regions; social structure and housing conditions in large cities.

The degradation of the natural environment in heavily industrialized areas and large cities gives rise to justifiable anxiety and encourages concern for significance of this factor in the state of health, the rate and causes of mortality, the pathology of reproduction, and also the migratory behavior of the population. The main research task was to discover the particularities of the course of demographic processes in towns with varying degrees of degradation of natural environment.

The study of the demographic consequences of degradation of natural environment in Poland, based on the example of large towns, has included three basic processes: births, deaths and migration (Witkowski, 1993). The study has concerned 29 large Polish towns located within the regions of ecological danger. Research results confirmed that the quality of the natural environment is one of the mortality factors in Poland. This is observed in the highest mortality rates in towns located in the regions of ecological peril. The impact of the quality of the environment on population mortality is most powerful among children and young people (Table 1). However, it occurred that higher mortality covaries with ecological conditions which are not always the worst. Therefore, the ongoing degeneration of the natural environment in Poland is not yet commonly reflected in mortality rates. Different and disadvantageous mortality patterns only occurred in strongly degenerated towns. The research has also shown that the quality of the natural environment is not unrelated to reproduction. The endangered towns are distinguished by the lowest levels of fertility as well as worse weight-specific structure of newborns. In spite of the many signs of the negative impact of the natural environment in Poland on the different dimensions of fertility, it is not a factor of decisive significance. However, its role increases systematically and it is most powerful in the most degenerated towns. The impact of the quality of the natural environment on migrations has so far been relatively weak. Factors which postpone the occurrence of this dependence have probably been operating, namely a difficult housing situation and socio-economic crisis. Only in the towns lying in the regions of ecological disaster was there observed a different migratory behavior among the population. However, if the degeneration of environment proceeds, we can expect the disadvantageous migratory tendencies to spread into other towns.

The concentration of negative demographic consequences in the most desolate regions suggests that only exceeding a certain limit of environmental pollution distinctly modifies demographic processes.

**Table 1. Infant mortality rates in ecologically endangered and remaining towns, Poland, 1985–1987.**

	Towns		Excess of mortality in endangered towns in %
	endangered	remaining	
<b>Age at death</b>			
0–27 days	14.6	12.9	113.2
28 days and more	4.4	4.1	107.3
<b>Cause of death</b>			
endogenous	15.1	14.3	105.6
exogenous	3.9	2.8	139.3
<b>Birthweight in gms.</b>			
3001 and more	6.0	5.7	105.3
3000–2501	12.8	10.5	125.9
2500–2001	45.0	52.8	85.2
2000–1501	159.3	167.0	95.4
1500 and less	477.5	548.3	87.1

Source: J.Witkowski, 1993.

Pollution of the natural environment also influences in a degrading manner the overall health status of the society. This influence is expressed in the form of the increasing risk of the appearance of many diseases both in children and in the adult population. There is too slow a decrease in the infant mortality rates, there are more and more children with congenital effects and low birth weight, and cases of premature births with lower chances of survival are more frequent.

Research conducted by J. Witkowski had also confirmed that the quality of the natural environment is one of the mortality factors in Poland. The general mortality level has become quite bad, for inasmuch as in the middle of the sixties mortality in Poland was close to European averages, it has rapidly increased in the middle of the eighties. The increase in mortality, observed since the middle of the sixties in Poland, has become a persistent phenomenon (Fig. 2). Activities undertaken aiming at overcoming the main causes of deaths, i.e. the so-called civilizational diseases (cardiovascular diseases, neoplasms, accidents, poisonings and violence, as well as diseases of the respiratory system) has not succeeded in stopping the spread of these diseases.

The territorial differentiation of mortality in Poland is very clear (Fig. 3). Highly polluted areas with the highest death rates, located in south-western parts (particularly the Katowice voivodship), represent the highest threat of human life. Low mortality levels characterize the eastern territories, along the belt stretching from North to South. These voivodships (especially the Bialystok voivodship) which represent the lowest life and health hazard are the least economically developed and least polluted rural areas.

My study on consequences of the environmental pollution for population in Poland (Potrykowska, 1992a), reports on testing of hypotheses as to the influence of environmental and socio-economic variables on the death rate levels at the regional scale. The results of a multiple regression analysis have confirmed the hypotheses forwarded. The fact of significance of the explanatory variables in the regression models confirms the negative influence of such factors as strenuous life conditions (overpopulation of apartments, bad sanitary state), hard work conditions, especially in mining and heavy industry, and catastrophic state of environmental pollution on the health status of Polish population and on the death rate<sup>4</sup>.

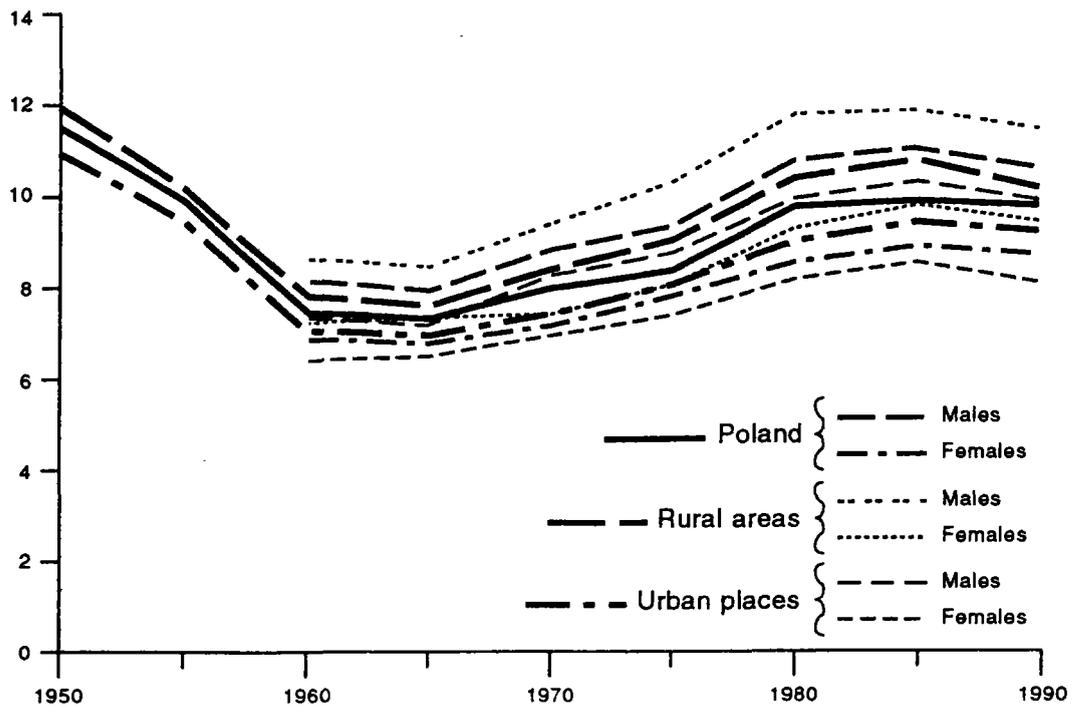


Figure 2. Crude death rates, Poland, 1950–1990.  
 1. Poland, 1a– Males, 1b– Females  
 2. Rural areas, 2a– Males, 2b– Females  
 3. Urban places, 3a– Males, 3b–Females

Source: Various Demographic Yearbooks, Warsaw, GUS.

The disadvantageous epidemiological situation related to the spread of mortality does not only depend on the functioning of the health care system, but also upon the negative changes taking place: 1) in the natural environment, 2) in the conditions of life and work, life style (the diet and hygiene), as well as upon 3) the level of the health care and culture of the society, education, and popularization of adequate patterns of health-oriented behaviour, and the development of prophylactic measures; and 4) life style and bad habits especially high rates of consumption of tobacco (first place in the world) and alcohol. The spread of the smoking habit among young people, including females, is associated with the increase in death rates from cancer and some diseases

of the respiratory and digestive tracts. The unprecedented, high consumption of alcohol, the habits related to it, and the way the alcohol is drunk, are linked with mortality caused by cirrhosis, cardiovascular diseases, some disorders of the nervous system, as well as violent causes.

According to the recommendations of the Governmental Demographic Commission the influence exerted by the pollution of natural and work environments on the excessive mortality should become the subject of the intensive studies meant for forming the basis of the prophylactic examinations and health care in Poland (Demographic Situation of Poland, 1991).

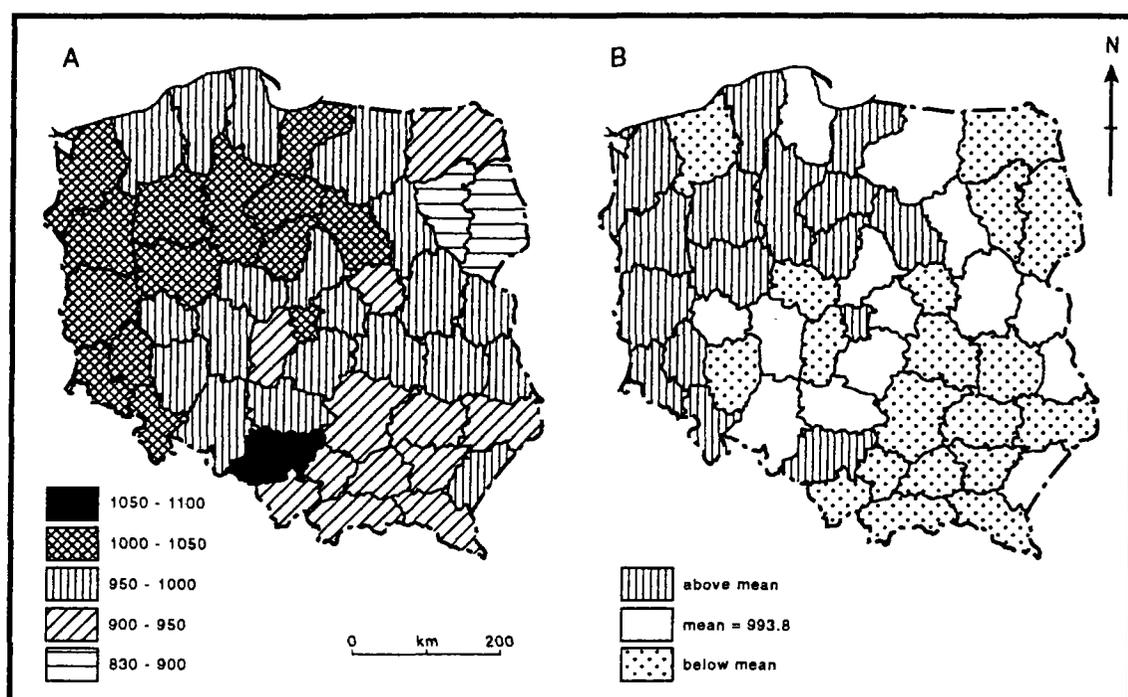


Figure 3. (a) Standardized death rates, Poland, 1988  
(b) Deaths per 100 000 inhabitants.

## 5. Strategies of International and National Policy. Comparative P-E Studies

The geographic position of Poland leads to transboundary water and air pollution. The transboundary pollution needs the international action and environmental policy between the neighbouring countries. Actually, the emission of the main pollutants, sulphur dioxide and nitric oxides, totals 5.5 million tons a year. On about a half of the country's area, the mean annual concentration of  $\text{SO}_2$  exceeds 20 mg per  $\text{m}^3$ . Apart from this, large quantities of  $\text{SO}_2$  (1.4 million tons annually) are imported from neighbouring countries through transboundary pollution (from the south: Czechoslovakia and other southern countries; and from the west: particularly Germany and other West European countries) (see Fig. 4). Polish forests are exposed to a very strong influence of polluted air. Sulphur dioxide induces acid rain which has caused

serious damage to forests in some regions. The dying of forests in the Sudeten and Carpathian Mountains is connected primarily with transboundary air-borne pollution from Czecho-Slovakia. Poland also exports 1.7 million tons of SO<sub>2</sub> emissions to downwind neighbours in Scandinavia and the Baltic Republics, and in turn the Chernobyl nuclear accident in the Ukraine aggravated human health in north and south-eastern Poland.

Poland's water balance is particularly unfavourable. The deficit of water is a very serious problem, which is aggravated by the high degree of contamination of surface waters. Over 60 per cent of the length of Polish rivers carry water that is too polluted to be used for municipal purposes and 40 per cent is too polluted to be used in industry. The most polluted rivers are the ones that carry the most water, especially the biggest rivers: the Vistula, the Oder, the Warta and the Bug, which are partly polluted by our neighbours. Polluted waters from Germany, Czecho-Slovakia, Byelorussia and Ukraine are reaching our territory by the Neisse, Oder and Bug rivers respectively, while Poland is a source of Baltic contamination, namely by the waters of the Vistula and Oder Rivers. The protection of water quality is directly connected with the protection of the Baltic Basin, to which Poland contributes about 20 per cent of the water. The state of sea water is an especially important problem. Enormous quantities of biogenic nitrogen and phosphorous salts reach the Baltic Sea, which initially caused a vigorous development of biological life, and the secondary contamination of the reservoir with residues of decaying organisms. Water contamination caused increased costs in the water supply and treatment for the people and industry; decline of fish stock; degradation and contamination of water ecosystems for irrigation in agriculture and horticulture; abandonment of many bathing places and beaches; and dissemination of diseases among animals and people.

Poland is extremely interested in activities to develop a regional strategy for environmental protection (Fig. 5). In the last few years has been appeared a new idea for the creation of a huge area whose main function will be to maintain the richness of nature and valuable environmental features. This area is called the "Green Lung of Poland", and is being created in five adjacent voivodships which cover about 15 per cent of the area of the country (Fig. 6). Lying behind this idea is a basic assumption about the appropriate steering of economic growth in these areas, so that eco-development (sustainable development) can occur. The major resources of these areas will be the valuable features of the environment, and the source of income for the people – agriculture producing organic produce, and eco-tourism. This concept is supported internationally and by non-governmental and scientific organizations. The new concept is extended beyond the Polish borders, on the territories of Lithuania, Latvia, Estonia and Byelorussia. Such new co-operation, through the new relationships struck up with both formerly-communist countries and northern countries. On the Polish side such areas are often in National Parks or reserves, whilst on the other side their protection is less strict. It may also happen the other way round – with areas recognized as particularly valuable in neighbouring countries having no protected status in Poland. Current cross-border co-operation, through the creation of a common protective strategy and the integration of protected areas, is occurring on the borders with Byelorussia, Ukraine, Czecho-Slovakia and Germany, and concerns above all the Bialowieza National Park, the Tatra Mountains, the Bieszczady

Mountains, the Karkonosze Mountains, the waters of the Baltic and areas along the Oder River.

A more active role of local communities on both sides of the borders should be a significant element to the improvement of the environment in those areas. The state administration at the central and regional level, as well as the local self-government, should provide assistance, which should facilitate an access to all forms of information on the state of the environment and sources of pollution hazardous for human health.

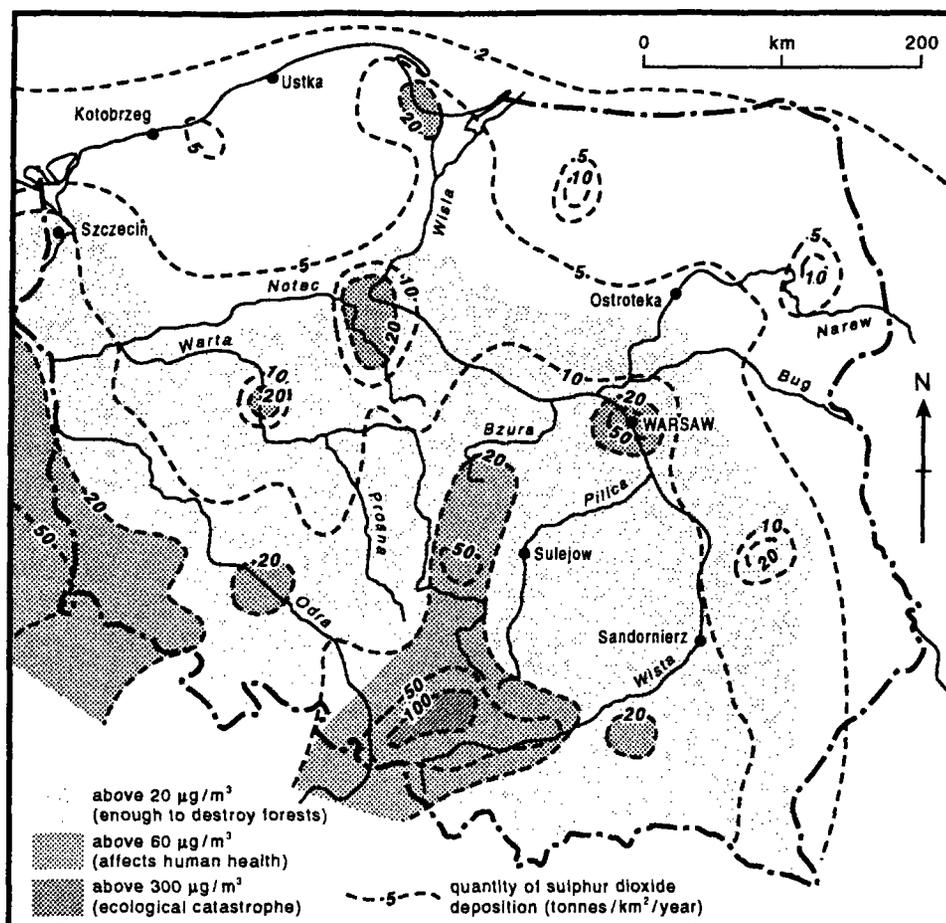


Figure 4. Transboundary pollution of Sulphur dioxide in Poland. Average annual concentration  $\text{SO}_2$ , 1978.

- 1- above 20 $\text{g}/\text{m}^3$  (enough to destroy forests)
- 2- above 60 $\text{g}/\text{m}^3$  (affects human health)
- 3- above 300 $\text{g}/\text{m}^3$  (ecological catastrophe)
- 4- quantity of  $\text{SO}_2$  deposition in tonnes/ $\text{km}^2$ /year

Source: F.W.Carter, 1989, p.177

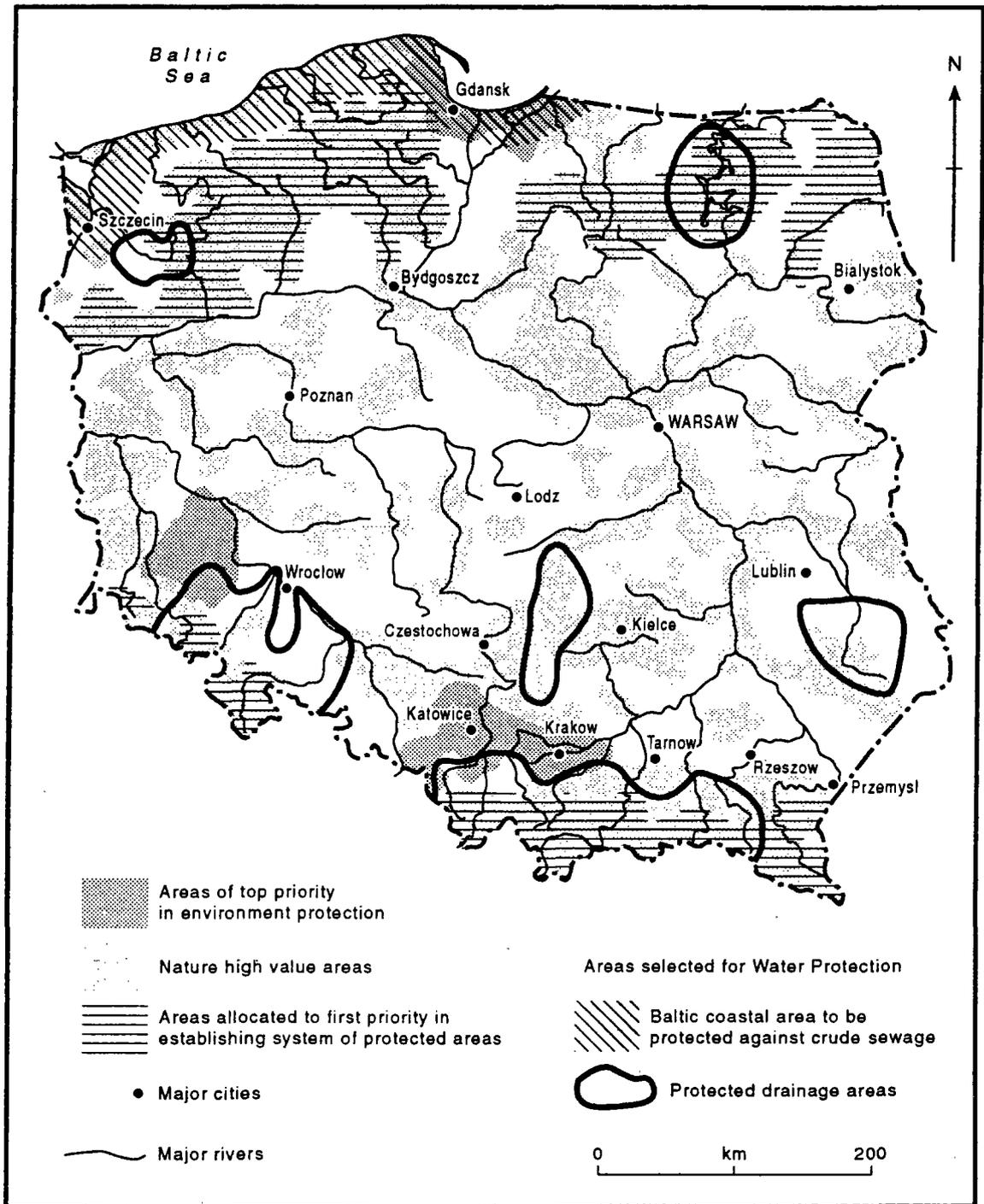


Fig. 5. Environmental protection in Poland.  
 Source: *Regional Policies in Poland*, 1991.

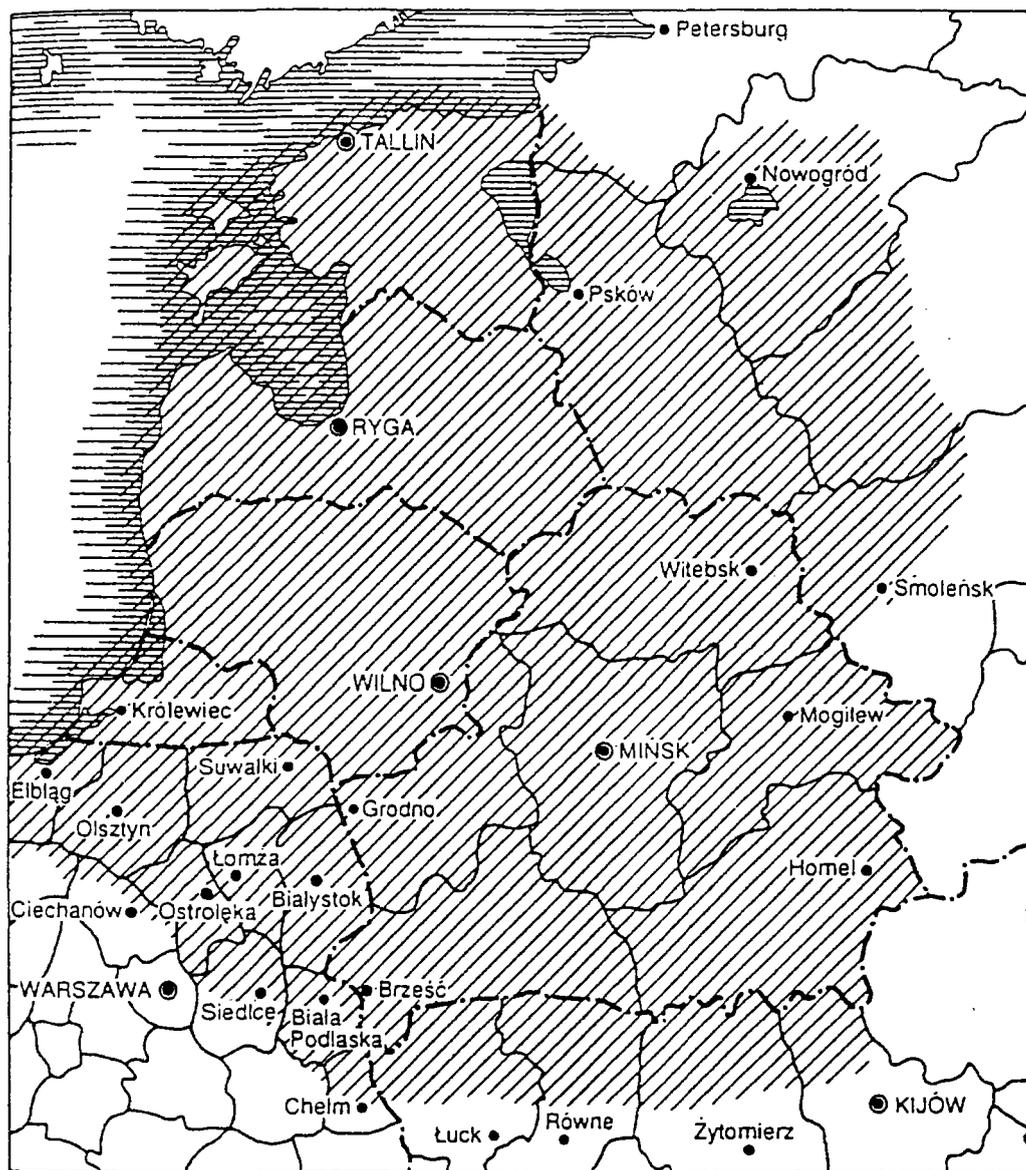


Fig. 6. "Green lungs" of Europe. Source: Degorska, 1993.  
Source: Degorska, 1993

### Footnotes

1. A bank of population and natural environment data is being created for the common purposes of researchers involved in the P-E studies, and others, at the Laboratory of Geographical Information Systems of the Institute. The Department of Population Geography and Urban Studies headed by Prof. P. Korcelli is undertaking population change and migration studies; fertility and mortality analyses; multiregional population projections; studies of internal and international migration. The new approach to the population-environment study is developing (Potrykowska, 1992).

2. The expert report on depopulation of rural areas in Poland, conducted under the direction of Prof. A. Stasiak, head of the Department of the Spatial Organization, was presented last year to the governmental Commission of the Spatial Organization and Economy (Stasiak *et al.*, 1991; Eberhardt, 1992). This study has been diffused and discussed by demographers, planners, and politicians, because of its importance for the present and future demographic and socio-economic structure of rural areas.
3. The main research topics conducted in the Institute of Geography and Spatial Organization of Polish Academy of Sciences are: field research and strategies of P-E development in frontier regions; international comparative studies of Eastern and Western frontier regions in Poland (Potrykowska, 1992b; Degórska, 1993).
4. Therefore, the hypothesis adopted in the analysis states that environmental and socio-economic factors have influenced the mortality in Poland. A multiple regression was run with a matrix of observations of dimensions 35x49, in which 35 variables for 49 voivodships were contained. Because of comparability of variables in the adopted territorial setting, 19 explained variables were described in the form of standardized death rates according to sex, cause of death and the character of residential location, while 16 explanatory variables were presented as structure and intensity coefficients, expressing the environmental and socio-economic characteristics of voivodships (Table 2). In order to limit the set of explanatory variables to the most significant, the step-wise regression algorithm was applied, and finally 19 regression equations were obtained (Table 3). In the first stage 5 regression equations were analysed.

**Table 2. Variables used in the multiple regression analysis of mortality in Poland**

***Dependent variables***

D –	Standardized death rate, Poland
DF –	Female standardized death rate
DM –	Male standardized death rate
DU –	Standardized death rates. Urban areas
DR –	Standardized death rates. Rural areas
C –	Standardized death rates. Cardiovascular diseases, Poland
CF –	Female standardized death rate. Cardiovascular diseases
CM –	Standardized death rate. Cardiovascular diseases
CU –	Standardized death rate. Cardiovascular diseases. Urban areas
CR –	Standardized death rate. Cardiovascular diseases. Rural areas
N –	Standardized death rate. Neoplasms, Poland
NF –	Female standardized death rate. Neoplasms
NM –	Male standardized death rate. Neoplasms
NU –	Standardized death rate. Neoplasms. Urban areas
NR –	Standardized death rate. Neoplasms. Rural areas
A –	Standardized death rate. Accidents, poisonings, violence. Poland
AM –	Male standardized death rate. Accidents, poisonings, violence.
AU –	Standardized death rate. Accidents, poisonings, violence. Urban areas
AR –	Standardized death rate. Accidents, poisonings, violence. Rural areas

## ***Independent variables***

### **DEMOGRAPHIC**

- PD – Density of population per km<sup>2</sup>
- U – % of urban population in total number of population
- I – % population employed in industry
- IF – % females employed in industry

### **HOUSING, SANITARY AND LIVING CONDITIONS**

- PPR– Persons per room
- WC – Consumption of water from water supply in hm<sup>3</sup> (106 m<sup>3</sup>)
- GC – Consumption of gas in hm<sup>3</sup>
- TR – Number of passengers in urban transport (mln persons)
- LW – Industrial and municipal liquid of wastes requiring purification but discharged to surface waters in 106 cu. m<sup>3</sup> per km<sup>2</sup>
- G&D– Emissions of dusts and gases in tons per km<sup>2</sup>
- IW – Environmentally harmful industrial wastes accumulated within industrial plants in tons per km<sup>2</sup>
- F – Surface of forests in hectares
- FD – Forest surface in the areas endangered by industrial emissions in hectares

### **MEDICAL SERVICES**

- MD – Number of medical doctors per 10 thousand inhabitants
- HB – Number of hospital beds per 10 thousand inhabitants
- FZR– Mineral fertilizers use in kgs per hectare of agricultural land

In the first model six independent variables account for 57 per cent of the variance of the standardized death rate. The most significant variables are: urbanization index (U), degree of ecological danger (IW, FD), sanitary conditions (WC), as well as the state of the health care system (ND, HB). In two consecutive models describing the influence of environmental and socio-economic factors on death rates of females (DF) and males (DM) the same independent variables describing housing conditions are significant. In the fourth model 8 significant variables (the same as in the first model plus PPR and LW) account for 50 per cent of variance of standardized death rates in urban places. In the fifth model, representing the influence of 4 socio-economic variables on death rates in rural areas, the most significant variable is the mineral fertilizer use in kgs per hectare of agricultural land. This confirms the hypothesis that excessive use of chemicals in agriculture is the cause of mortality. The other three variables describe living conditions (GC) as well as the state of environmental pollution in rural areas (G&D). The share of variance is 46 per cent.

The following group of models describes the influence of explanatory variables on the spatial differentiation of death rates according to causes, sexes and rural-urban residential locations. Among the models describing mortality due to cardiovascular diseases (C,CR) the highest fit was noted in the eight model  $R^2 =$

28 per cent), in which the mortality of males from these diseases depended upon 7 independent variables expressing life conditions in urban places, including population density (PD) and urbanization index (U), as well as industrial employment (I), housing and sanitary conditions (PPR, WC), and accessibility of the health care system services and facilities (MD, HB). This, again confirms the supposition that urban ecosystems are less favourable for males, who are more sensitive to stresses and hard life conditions in urban environment. In the subsequent model (CR) the most significant independent variables influencing the death rates in rural areas due to cardiovascular diseases are: forest surface, which positively influences the health condition of population, and accessibility of the health care services (MD, HB), the latter having, very often, especially in rural areas, a direct importance for the possibility of saving human life.

The greatest share of variance of dependent variables formulated as death rates due to neoplasms, according to sex and rural-urban location, is explained by these independent variables which turned out most significant in the third group of models (N,NR). Some 70 per cent to 90 per cent of the variance of the mortality due to cancer can be ascribed to the impact of ecological factors. Deaths due to neoplasms dominate in strongly industrialized, polluted towns (model NU) and in the male population (model NM), which is corroborated by significant independent variables representing dust emissions and industrial employment, as well as consumption of water from water supply systems (drinking water contains various detergents, bleaching substances, chemical and metallurgical wastes, pesticides etc., which cannot be entirely excluded, and even when the biological oxidation of organic substances is properly performed, the end products of this process may be toxic in conditions of high concentration.

**Table 3. Stepwise regression results for mortality in Poland, 1988**

No.	Regression equation	R <sup>2</sup>
1.	$D = 897.94 + 2.66U + 0.15WC - 0.0003IW + 0.055FD + 0.66HB - 6.09MD$	57
2.	$DF = 829.58 + 0.27WC - 1.53LW + 0.003FD + 2.26U - 5.74MD + 0.33PD$	52
3.	$DM = 728.92 + 72.72PPR + 0.19WC - 0.003IW + 0.13FD - 4.41MD + 0.32HB + 2.41U$	46
4.	$DU = 611.73 + 3.48U + 137.9PPR + 0.22WC + 0.34LW - 0.77IW - 0.22FD - 9.4MD + 2.3HB$	50
5.	$DR = 668.15 - 0.11GC + 0.71FZR + 260.8PPR + 0.36GD$	46
6.	$C = 424.8 + 2.49I + 0.08LW - 0.09GD + 0.001IW + 0.07FD$	25
7.	$CF = 409.4 + 0.06PD + 2.7I - 0.28LW + 0.005I$	24
8.	$CM = 411.25 + 0.11PD + 0.46U + 1.97I - 0.084WC - 0.65LW + 0.03IW + 0.29FD$	27
9.	$CU = 399.36 + 2.02I - 0.02WC + 0.02LW - 0.001IW + 0.21FD$	18
10.	$CR = 345.04 + 2.22I + 120.3PPR - 0.23WC + 0.15MD + 0.47HB$	41
11.	$N = 142.04 + 1.61U - 11.38PPR + 0.06WC - 0.18TR + 0.01IW - 0.09FD - 0.05HB - 1.51MD$	75
12.	$NF = 126.29 + 1.3U - 25.13PPR + 0.07WC - 0.25LW - 0.09MD - 0.29HB$	78
13.	$NM = 150.52 + 1.94U + 3.42PPR - 0.03IW - 0.06I + 0.26HB - 2.85MD$	66
14.	$NU = 173.92 + 1.14U + 0.003WC + 0.002IW + 0.23HB - 1.78MD - 0.91I$	55
15.	$NR = 181.94 - 41.21WC + 0.25FZR$	56
16.	$A = 54.13 + 0.12U - 0.09I + 0.001IW + 0.51HB - 0.98MD$	31
17.	$AM = 87.05 - 0.01PD - 1.38MD + 0.814HB$	23
18.	$AU = 41.31 + 0.18U + 0.53HB$	20
19.	$AR = 58.62 + 0.54U - 7.93PPR - 0.99WC$	40

This problem has a connection with the significance of two variables (WC and FZR), which explain altogether 56 per cent of variance of the death rates due to neoplasms in rural areas (NR). In the twelfth model (NF) 78 per cent of variance of standardized death rates of females from cancer is explained by 6 independent variables related to degree of urbanization, housing, and sanitary conditions, and state of environment (TR), as well as health care system (MD,HB). Attention should be paid to the significance of the variable representing consumption of water from water supply systems, which are also related to the catastrophic situation as to waste-water purification in Poland. The majority of towns in Poland are not served by any water purification plant, including several large cities, Warsaw not excepted. Even purified water is not adequate in towns in view of its demineralization – it is deprived of various trace elements, which may result in definite deficiencies in the human organism. Even the inadequate system of water supply in rural areas has a very unfavourable influence upon the health of the rural population. In the majority of rural areas particularly in the eastern regions of Poland, the system of piped water is less developed. For example, in 1988, 56 per cent of households in the countryside were served by piped water, 38.9 per cent had a wc, 43 per cent a bathroom, 3.5 per cent gas and 33.4 per cent central heating.

In the last group of models, describing the influence of environment socio-economic variables on the death rates due to accidents and poisonings, the major part of variance of mortality levels related to these causes ( $R^2=30$  per cent) is explained by the variables expressing the degree of urbanization, industrial employment, as well as accessibility of medical service (MD). The remaining part of the variance is explained by other causes having important significance, which should be considered in future investigations. In order to better recognize the influence of different factors on the mortality level one should study the following elements: work conditions, housing conditions, life style, cultural and educational level, eating habits and diet, biological and health characteristics, living conditions in industrial and urban agglomerations, availability of sanitary facilities and equipment, as well as ecological conditions connected with the state of pollution of the natural environment.

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## CHAPTER 17

# HEALTH AND PERCEPTION OF PEOPLE ABOUT POLLUTION AROUND INDUSTRIAL ZONE OF BOMBAY

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### 1. Introduction

Two most glaring examples of fatal industrial accidents of the immediate past are the leakage of methyl isocyanate (MIC) from the Union Carbide Plant in Bhopal in 1984 and the emission of radio-nuclides from the nuclear power plant in Chernobyl in 1986. It is estimated that the former claimed over 4,000 lives and severely affected nearly 50,000 people, while nearly four million people were directly or indirectly affected by large-scale contamination in the Chernobyl accident (Narvane, 1992). Though management of any hazardous plant takes all the precautions to prevent any untoward incident, still the possibility of an accident cannot be eliminated completely. The extent of damage, if such an unfortunate incident takes place, depends not only upon the amount and toxicity of the material released by such factories, but also upon the proximity of people to these plants, prevailing wind direction and other weather conditions, city skyline etc.

Greater Bombay, the largest urban agglomeration in India, having around ten million people, is located in the crater of an industrial volcano. Any eruption of poisonous gases and lava of injurious chemicals will take away tens of thousands of lives and cripple many more. The numerous chemical industries located in Bombay keep releasing quantities of toxic, irritant gases and pollute the entire environment of the city. The major concentration of these industries in Bombay is in the Chembur-Trombay industrial belt, which is probably the smallest area with the largest industrial investment in India. It has two major petroleum refineries, a petroleum off-loading terminal, large industrial plants and many other smaller industries which use hazardous chemicals. Of the 32 hazardous factories at Chembur-Agra road, seven are in Chembur (Shridhar, 1992).

This area, which holds about 50 industries today, was once a piece of marshy land. It was covered with forests in 1810, when it was the part of the island of Trombay. Chembur still comprised jungles in the 1940s when the first refinery was set up and pollution was never felt in the area (D'souza, 1992). The proximity of this relatively uninhabited area to the sea and its considerable distance from the mainland Bombay prompted the government to target it as a high growth centre. The area was merged with Bombay Municipal Corporation (BMC) in 1957 and soon became the largest concentration of industries producing a range of petro and agrochemicals, cosmetics, pharmaceuticals, engineering and processing goods. With industries came the workers and with them more people to cater to their needs. With development and increasing population, Chembur and its surrounding area lost its flora and fauna and was

submerged in a variety of obnoxious gases released by the factories. This rightly earned the acronym "gas-chamber" for Chembur.

According to the Air and Water Quality Monitoring Unit BMC, 2971 tonnes of pollutants are let out in the air in Bombay every day. Nearly 46 per cent of this is contributed by the industries, 52 per cent by automobiles, and 2 per cent by the domestic sector (Kamat, 1992; Goenka, 1992). Fortunately, because of Bombay's coastal location, strong sea winds help in dispersing the air pollutants. However, during the winter, the excessive presence of suspended particulate matter (SPM) leads to temperature inversion and the city is visibly enveloped in a low lying pollution cloud. Studies show that a higher concentration of SPM in the air is particularly stressful for old people whose health is already poor. It increases the cases of pulmonary heart diseases and pneumonia.

" Rough estimates indicate that if unhealthy levels of SPM were brought down to the annual average level that WHO considers safe, between 300,000 to 700,000 deaths a year could be averted in developing countries..... Chronic coughing in urban children under the age of fourteen could be reduced by half (or about 50 million cases annually), reducing the chance that these children will face permanent respiratory damage" (World Bank, 1992).

The pollutants can cause health problems through direct exposure or indirectly through changes in the physical environment. In two major cases of direct exposure in the Netherlands and the United States homes were built on reclaimed land containing paint solvents, pesticides, chemicals used in making plastic and sludge from the bottom of stills. The children living on or near the site developed many serious health problems. Finally, the families had to be evacuated from both the sites (UN, 1990).

The evidence in the United States show that 2–3 per cent of all the cases of cancer are associated with environmental pollution (World Bank, 1992). But, the effect of pollution on the health of people in the developing countries is much more pronounced as they are comparatively less healthy and undernourished.

Environmental pollution also affects the reproductive health. It may cause sub-fertility, intra-uterine growth retardation, spontaneous abortion and various birth defects. In developing countries various infectious diseases, malnutrition and poor living conditions are important causes of reproductive health problems, whereas in developed countries chemical pollution, radiation and stress have become the major threats (WHO, 1991).

Environmental pollution has led to several health related problems among the Bombayites leading to respiratory disorders, lung infections, asthma, allergy etc.. Kamat *et al.* (1992) attributed the prevalence of several respiratory and other problems to the existing level of air pollution. They found higher incidence of respiratory infection in areas with high air pollution, particularly with high level of SPM and sulphur dioxide. The incidence of TB was found to be between 0.5 to 0.8 per cent and history of old TB between 0.8 to 1.5 per cent. The incidence of cancer was 69.1 per 100,000 females and 67.7 per 100,000 males in 1979–84. In the highly polluted areas cough and multiple chest infections were common at ages below 10 years (Srinivasan, 1990–91).

With this background in mind, the present study which was conducted in 1990 in a zone of 5km radius (covering 78.5km<sup>2</sup> area) around Rashtriya Chemicals and

Fertilizers (RCF) throws some light on the prevalence rate of respiratory and skin problems which could be caused by pollution among the inhabitants residing close to the industrial area; the spatial variation in the prevalence rate of actual suffering as one moves away from the industrial zone; the knowledge of residents about the polluters and the pollutants; their preparedness in case of any eventuality; and measures to be taken by them (right or wrong) if an unfortunate leakage of the hazardous chemicals takes place from any of these factories. It also gives some recommendations for reducing the sufferings from factory pollution and prevention of occurrence of any disaster in the area.

## 2. Methodology

The study was conducted in the M, N, L, G-south, F-south, F-north and H-east wards of Greater Bombay. Keeping RCF as the centre on the map, the area to be surveyed was marked at a distance of 5kms from the centre. The major objective of the study, which was conducted for RCF, was to estimate the population in this area. The map obtained from BMC showed the industrial and residential areas, no development zone and open spaces. The circle with 5km radius was enclosed in a square for sampling purposes. This big square was divided into 100 squares each of one km<sup>2</sup> size. Again each of these 100 squares was sub-divided into 100 small squares measuring 100 metres by 100 metres in size. All these squares were systematically numbered. In the residential areas, the small squares (100m by 100m) were stratified according to their density of residential structures as shown in the BMC map and 343 such squares (15 per cent of the total residential space in the study area) were selected using stratified random sampling procedure. After a rapid field reconnaissance another 66 small squares were selected from the open areas which were strewn all over by the slums. Only six small squares from the no development zone were found having some residential areas which were also included in the sample. For the purpose of estimating the population density, full population count was done in all these 415 selected small squares. In addition, detailed information was elicited from the first five households in each selected small square through a pre-designed questionnaire. After eliminating the cases of no response, locked or vacant houses, information was obtained in all from 1877 households.

## 3. Findings

In all, 9291 persons were staying in these 1877 households, indicating that the average household size was 4.95 persons. The estimated population of this 5km zone around RCF (78.5km<sup>2</sup> area) was 2.2327 millions (Roy *et al.*, 1991). Since most of the industries are located in the southern and eastern portion of the study area, the distances of the study blocks were calculated from the industrial area and grouped into three distance zones, viz. up to 1km (zone-1), 1 to 3km (zone-2), and 3 to 5km (zone-3). The estimated densities of population of these three zones were 15092, 42292 and 31864 per km<sup>2</sup> respectively. Fig. 1 shows the location of bigger squares in each zone and the pattern of their population densities.

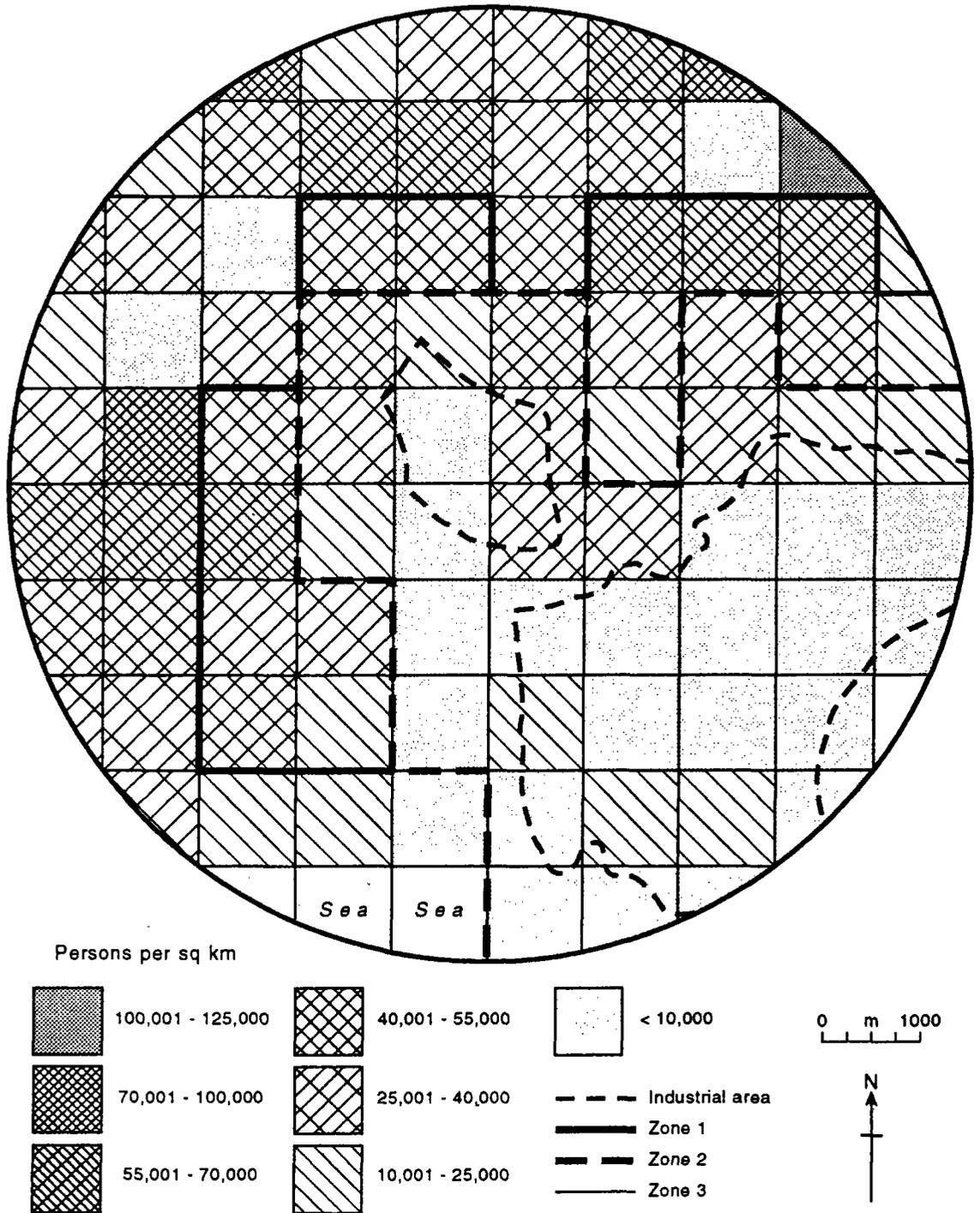


Fig. 1. Residential population density in big grids (weighted average density) in 5km zone around Rashtriya Chemicals and Fertilizers (RCF), Greater Bombay, October 1990.

**Table 1. General Characteristics of the Households (HH)/Population Interviewed**

	Zone			
	1	2	3	Total
Percentage of HH interviewed	21.9	32.0	46.1	100.0
Average HH size	5.3	4.8	4.9	4.9
Percentage of kutcha houses	16.2	14.3	12.6	13.9
Percentage of HH not having toilet facility	50.9	41.8	39.0	42.5
Percentage of HH not having water facility	43.7	32.3	29.9	33.7
Dependency ratio	48.9	46.2	32.3	47.5

Note: Kutcha house refers to a dwelling unit made up of materials like unburnt bricks, bamboos, mud, thatch, etc.

Table 1 presents the general characteristics of the households interviewed as well as the population covered during the survey. It shows that nearly one-fifth of the households were residing in zone-1, about one-third in zone-2 and 46 per cent in zone-3. More than two-fifths of the households did not have any toilet and one-third any water facility within the house. About 14 per cent households in the entire study area were staying in kutcha houses. In zone-1, which was closest to the industrial area the living conditions, both in terms of quality of house and availability of basic amenities within the house, were much worse than in zones 2 and 3. To make the matter worse, these poor quality houses were accommodating more people in zone-1 as is reflected by their larger average household size. Apart from that, this zone also had the highest dependency ratio, particularly the young dependency ratio. In a nutshell one can say that the living conditions of people in zone-1 were most unfavourable. At several other places also it has been observed that the concentration of the poorer sections of society is greater near industrial units, which makes them most the vulnerable group to any industrial hazard.

#### **4. Complaint Rate about Pollution Related Health Problems**

Evidence from other countries show that chronic exposure to pollution may lead to exacerbation of bronchial asthma, recurring lung infection, frequent nasal, throat and eye irritation and emphysema. The common clinical complaints caused by exposure to pollutants may be headache (NO<sub>2</sub>, aldehyde, benzene), eye irritation (ammonia, aldehyde, NO<sub>2</sub>), watery nasal discharge and sneezing (SO<sub>2</sub>), irritating cough (SO<sub>2</sub>,

SPM), choking and chest pain (NO<sub>2</sub>), irritability, anginal pain, ECG changes on exercise (CO) and productive cough (SO<sub>2</sub>, SPM) (Kamat, 1992).

**Table 2. Age Distribution of Population and Pollution-related Health Complaint Rate**

Age group	Percentage of Population				Health Complaint Rate			
	Zones				Zones			
	1	2	3	Total	1	2	3	Total
0-14	28.3	25.	25.6	26.2	12.3	8.7	4.7	7.8
15-59	67.2	68.	67.7	67.8	23.3	15.2	14.0	16.5
60 +	4.5	5.	6.7	6.0	34.3	27.7	21.6	25.6
All ages	100.0	100.	100.0	100.0	20.7	14.3	12.1	14.8

The percentage of households with at least one complainant declined from 50 per cent in zone-1 to 43 per cent in zone-2 and 40 per cent in zone-3. The overall rate of health complaints amongst the residents was 14.8 per cent for this part of Greater Bombay, which declined as one moved away from the industrial area (20 per cent in zone-1 to 12 per cent in zone-3, Table 2). This pattern was found to be true for all age groups. However, the complaint rate was lowest among children and highest among old people, which could be because children, especially small ones, either do not know about their problems or do not report them even if they are suffering. On the other hand, old people generally complain more about their health problems which also increase because of the age factor.

Table 3 depicts the pollution-related health complaint rates by broad age groups and household characteristics in different zones. It is observed that generally the complaint rates declined as one moved away from zone-1 to zone-3 in all the age-groups except for old people (aged 60 +) staying in kutcha houses and without availability of water within the house. This could be because of the overall small sample size in that particular category. Another noteworthy feature of this table is that the households with comparatively deprived living conditions had a lower complaint rate in all the three zones. The lower complaint rates among the deprived households with poor living conditions indicate their lower sensibility to minor complaints, such as headache, irritation in eyes, etc. However, the differentials in complaint rates by living conditions were generally low in zone-1 and quite high in zone-2. The perpetual suffering of people from these complaints in zone-1 reduces the differentials in the complaint rates by living conditions of the family.

**Table 3. Rate of Health Complaints by Household Characteristics and Broad Age-Groups**

Age-group Zone	Household characteristics					
	Type of construction		Water available		Toilet available	
	Kutcha	Non Kutcha	No	Yes	No	Yes
<b>Age 0-14</b>						
Zone-1	12.7	11.9	11.8	12.3	9.4	15.8
Zone-2	1.5	10.3	3.2	12.1	3.7	13.5
Zone-3	2.1	5.2	2.9	5.8	3.6	5.6
Total	4.8	8.4	9.2	5.8	5.3	10.2
<b>Age 15-59</b>						
Zone-1	25.0	23.1	24.8	22.3	22.2	24.6
Zone-2	13.7	15.4	10.2	17.5	11.0	18.2
Zone-3	11.7	14.4	12.7	14.7	12.5	15.0
Total	15.6	16.7	15.5	17.1	14.8	17.9
<b>Age 60+</b>						
Zone-1	14.3	35.9	30.8	35.6	28.2	38.3
Zone-2	0.0	29.1	23.3	28.7	30.0	26.7
Zone-3	22.2	21.6	32.1	20.4	30.3	18.9
Total	12.5	26.4	28.6	25.3	29.7	24.2
<b>All ages</b>						
Zone-1	20.1	20.7	20.6	20.7	18.9	23.2
Zone-2	9.2	15.0	8.5	17.0	9.7	17.7
Zone-3	8.5	12.7	10.0	13.2	10.5	13.2
Total	11.7	14.1	12.7	15.9	12.5	16.6

Table 4 shows that there is a direct correspondence between the educational level of the respondents and the health complaint rates. The uneducated reported least complaints in all zones, whereas those with secondary and above qualification reported most complaints. However, the complaint rate declined in almost all the categories as one moved away from the industrial zone. The pattern is almost identical for all the age groups. It seems that an uneducated person is less sensitive to perceive the complaints like headache and irritation in eyes as real ailments. On the other hand, the educated persons, particularly in the areas located closer to the industries, not only reported more health complaints but also related them to the industrial pollution.

In addition, a greater proportion of households in zone-1 had complained of pollution-related ailments, but also a relatively greater proportion of household members here were reported to be suffering from such ailments. This was true notwithstanding the fact that people in this area were relatively young and unfavourably placed in terms of level of living among whom the complaint rate was in general low.

**Table 4. Rate of Health Complaints among Residents by Educational Level of the Respondents**

Age group Zone	Level of Education			Overall
	No Schooling	Below Secondary	Secondary & above	
<b>Age 0-14</b>				
Zone-1	12.1	9.9	14.0	12.3
Zone-2	7.2	9.4	8.8	8.7
Zone-3	3.9	4.2	5.2	4.7
Total	7.6	7.2	8.3	7.8
<b>Age 15-59</b>				
Zone-1	17.6	23.5	25.1	23.3
Zone-2	7.9	11.8	19.3	15.2
Zone-3	13.5	10.2	16.0	14.0
Total	12.9	14.0	18.9	16.5
<b>Age 60+</b>				
Zone-1	26.7	34.5	36.4	34.4
Zone-2	15.8	23.3	31.7	27.7
Zone-3	20.8	23.0	21.2	21.6
Total	20.7	25.6	26.7	25.6
<b>All ages</b>				
Zone-1	16.2	21.2	23.0	20.7
Zone-2	8.0	11.6	18.2	14.3
Zone-3	11.1	8.9	14.0	12.1
Total	11.6	12.4	17.1	14.8

## 5. Major Health Complaints

The most common clinical complaints in the area were irritation in the eyes, chronic headache, sore throat or cough and skin itching. Table 5 shows the prevalence rate of these problems according to distance of the complainants from the industrial area by age groups.

It is clear from this table that eye irritation declined substantially as one moved away from the industrial area (from 12.1 per cent in zone-1 to 5.1 per cent in zone-3). Chronic headache and sore throat/cough had lower complaint rates and showed a slight decline across the zones. They remained almost at the same level in the second and third zones. The skin itching and breathing problem hardly had any spatial variation. The pollution caused by automobiles, which is omnipresent in Bombay, might be responsible for the same prevalence rate of these complaints in different areas. The type of complaints also differed according to the age of the complainants: while skin itching and sore throat were more prevalent among children, older people complained more about eye irritation and chronic headache. This table suggests that the industrial pollution is largely responsible for eye irritation and to some extent for chronic headache and sore throat/cough.

**Table 5. Health Complaint Rate by Age and Type of Complaint**

	0-14	15-59	60+	Total
<b>Zone-1</b>				
1. Eye irritation	6.0	14.0	23.2	12.1
2. Skin itching	2.0	1.5	1.0	1.6
3. Chronic headache	0.7	3.2	7.1	2.7
4. Sore throat/cough	1.3	2.7	1.0	2.3
5. Breathing problem	0.2	0.6	2.0	0.6
6. Others	2.1	1.3	0.0	1.4
Total	12.3	23.3	34.3	20.7
No. of persons	(620)	(1474)	(100)	(2194)
<b>Zone-2</b>				
1. Eye irritation	1.8	8.1	18.1	7.1
2. Skin itching	2.6	1.3	1.2	1.7
3. Chronic headache	0.5	2.7	2.4	2.1
4. Sore throat/cough	1.5	1.1	3.6	1.3
5. Breathing problem	0.4	0.7	1.8	0.7
6. Others	1.9	1.3	0.6	1.4
Total	8.7	15.2	27.7	14.3
No. of persons	(740)	(1962)	(167)	(2869)
<b>Zone-3</b>				
1. Eye irritation	0.8	6.4	7.6	5.1
2. Skin itching	1.5	1.6	2.9	1.6
3. Chronic headache	0.3	2.7	3.6	2.1
4. Sore throat/cough	1.3	1.5	2.5	1.5
5. Breathing problem	0.2	0.5	4.0	0.7
6. Others	0.6	1.3	1.0	1.1
Total	4.7	14.0	21.6	12.1
No. of Persons	(1084)	(2864)	(280)	(4228)

## 6. Knowledge and Perception about Pollution

Of late the public sensitivity and awareness towards environmental pollution and related issues has become a potent force in many political and development decisions. In 1988 and 1989 the Harris Polling Organization surveyed public opinion and leadership attitudes around the globe on behalf of the United Nations Environment Programme. The survey findings revealed a widespread concern about the quality of environment. Most of those surveyed believed that their environments had become worse in the past decade (Louis Harris and Associates, 1988; 1989). In our survey also some questions were asked to ascertain the extent of knowledge of the respondents about pollution-causing factories around the surveyed area as well as pollutants released by these factories. On the basis of these questions the respondents were classified into the following three groups: (1) those who did not have any idea about any factory-causing pollution or any pollutant, were classified as having no knowledge, (2) those who had knowledge either about one factory or one pollutant or both were categorized as having a low level of knowledge, and (3) those who had knowledge about more than one factory or pollutant or both were classified as having good knowledge.

Table 6 presents the relevant data to gauge the respondents' knowledge about industrial pollution according to their literacy status. In general, compared to illiterate respondents a higher proportion of literate respondents had knowledge about industrial pollution. Similarly, the extent of knowledge was also found to be higher for literate respondents. The knowledge about industrial pollution declined with increasing distance from the industrial zone irrespective of the literacy status of respondents. The increase in the proportion of those who did not have any knowledge about industrial pollution among both literate and illiterate respondents from zone-1 to zone-2 was very striking. Equally striking was the widespread knowledge about industrial pollution in zone-1 where around 83 per cent of both literate and illiterate respondents were aware of industrial pollution and where 40 per cent of illiterate respondents and more than half of the literate respondents had good knowledge about industrial pollution. This may be an outcome of the day-to-day exposure and the physical discomforts experienced by the residents in this zone because of persistent air pollution.

**Table 6. Distribution of Respondents by Literacy Status and Knowledge about Industrial Pollution**

Level of Knowledge	Zone							
	1		2		3		All area	
	Illiterate	Literate	Illiterate	Literate	Illiterate	Literate	Illiterate	Literate
No knowledge	16.7	17.5	52.3	34.4	66.3	55.0	48.3	40.6
Low knowledge	43.3	30.0	34.9	36.5	25.6	26.8	33.6	30.5
Good knowledge	40.0	52.5	12.8	29.1	8.1	18.2	18.1	28.9
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

An attempt was also made to ascertain the knowledge of the respondents about Bhopal gas disaster according to literacy status (Table 7). In this case also a higher proportion of literate than illiterate respondents were having knowledge about it, but unlike industrial pollution, the proportion of both literate and illiterate respondents having knowledge about it was the least in zone-1. Besides, the difference in proportion of respondents having knowledge about the Bhopal gas disaster between literate and illiterate respondents was very striking in zone-1 compared to other two zones. This again substantiates our earlier observation that a higher level of knowledge about industrial pollution in zone-1 even among illiterate respondents is because of the persistent air pollution and consequential discomforts experienced by the residents of this zone.

## 7. Preferred Measures to Tackle any Disaster

The respondents were also asked to give their views on how they perceived the possibility of an industrial disaster in this area, what measures could they suggest to avoid such a disaster and what type of system they thought could warn people to prepare themselves to face the situation in case of such an eventuality. The results of these interrogations are presented in Tables 8 and 9.

**Table 7. Percentage of Respondents by Literacy Status Having Knowledge of the Bhopal Gas Disaster**

Literacy Status	Zone		
	1	2	3
Illiterate	39.6	58.8	47.5
Literate	64.6	67.0	59.5

**Table 8. Distribution of Types of Measures Suggested to Avoid Disaster by Level of Education of the Respondents**

Measures	Literacy Status	
	Illiterate	Literate
Better maintenance	43.0	46.2
Shifting of factories	30.2	29.7
Reduction of pollution by increasing the height of chimney	12.0	8.7
Regular check-up of plants	12.7	11.1
Provision of gas masks by the industries	0.7	1.8
Planting more trees	1.4	2.5
Total	100.0	100.0

It is observed that a large proportion of respondents have suggested better maintenance of the factories and shifting of factories away from the densely populated area as remedies to avoid any industrial disaster (Table 8). Of the two suggested measures, the percentage of respondents indicating better maintenance was found to be higher (46 per cent) than those suggesting shifting of factories (30 per cent). However, the situation did not appear to be very different when the literacy status was accounted for. It is apparent from this table that more literate respondents had opined about better maintenance of factories. A sizable number had suggested that raising the height of chimneys might reduce pollution and in turn the risk of any disaster. The

percentage of illiterate respondents suggesting this measure was higher than the literate respondents. Almost 12 per cent respondents had suggested regular check-up of plants as one of the remedies to avoid disaster, with some variation when literacy status was considered. However, a very small proportion of people suggested tree plantation in the area to reduce the effect of pollutants.

In case of any gas leakage, it was considered necessary to have a warning system to make people aware of an industrial accident and take some precautionary measures in order to safeguard themselves from the hazardous situation. Accordingly, suggestions were taken from the respondents regarding such a warning system, and the same have been tabulated in Table 9 according to their literacy status.

**Table 9. Suggested Warning Systems to be used at the time of Disaster by Literacy Status of Respondents**

Warning System	Illiterate	Literate
Siren	51.2	59.2
Police horn	26.2	19.7
Hospital bell	8.1	5.0
Radio/T.V.	7.6	7.3
Loudspeaker	5.2	7.4
Electronic warning device	1.7	1.4
Total	100.0	100.0

It was observed that more than half of the respondents had preferred a siren as a means of warning system followed by a police horn. Whereas a siren was preferred more by the literate group, a police horn was preferred by a larger proportion of illiterate respondents. Some of the respondents had also suggested radio/T.V, hospital bell and loudspeaker as the other means of warning system.

## 8. Recommendations

The existence of a large number of gas-emitting factories in the densely settled surroundings of Chembur and the high rate of health complaints related to pollution call for immediate steps to mitigate the sufferings. While the need for controlling the level of pollution in the area is imperative, there is an urgent need for undertaking programmes to inform and educate the masses about pollution and for measures to be taken to alleviate the level of sufferings. Since a large number of people live in the vicinity of hazardous factories, special emphasis should be given to the preparedness of people to meet any disaster in the area and the appropriate steps to be taken by them to face such eventualities. The following specific recommendations are worth considering.

### **8.1. Measures to mitigate sufferings:**

- i) Educating the residents regarding types of pollution and their likely effects on health.
- ii) Generating awareness about seasonal and diurnal variations in the level of pollution and measures to be taken to minimize the effect of pollution.

### **8.2. Measures to reduce the level of pollution:**

- i) Regular maintenance and upgrading of machines and, if required, increasing the height of chimneys.
- ii) Restricting any expansion of the existing chemical factories and addition of such new factories in the area.
- iii) Further increase in the density of population in this area to be thwarted.
- iv) Tree plantation programmes in and around the factories to be undertaken/strengthened.

### **8.3. Measures to be taken to meet any catastrophe:**

- i) Educating and training people about precautionary and safety measures to be taken in the event of any industrial accident. It becomes very pertinent as during the survey many people said that they would rush towards the railway stations to protect their lives in case of an accident. Such actions may lead to total chaos and confusion and create hurdles in the evacuation and relief measures.
- ii) Proper warning system to be evolved to inform public about an industrial accident.
- iii) Water resources and other relief measures to be installed and mobilized at the time of an eventuality.

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## CHAPTER 18

# SLUM AND THE URBAN ENVIRONMENT; STUDY OF A SQUATTER SETTLEMENT IN DELHI

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### 1. Introduction

Who are the slum and squatter settlement dwellers? Where do they come from? What are the environmental consequences of slum and squatter settlements? These are the perpetual questions facing the metropolitan cities of today's India (Govt. of India, 1983, 1985; Nangia, 1987, 1988; Seshan, 1983; Singh and de Souza, 1980).

A survey conducted in December 1991 by the students pursuing their Master's degree in Geography at the Jawaharlal Nehru University, New Delhi, India sought answers to these questions in the context of our concern for urban poverty and degradation of urban environment, while undertaking a complete survey of an urban squatter settlement named 'Bhoomiheen Jhuggie - Jhonpuri camp' (cluster of temporary shelters for the landless) in the southern part of metropolitan city of Delhi. This squatter settlement of approximately 1510 households stretches over an acre of public land near middle and upper middle income-group colonies where land values go sky-rocketing. The squatter settlement occupied the land lying between the railway-line and a link-road nearly 12 years ago, and has extended to the other side of the road as well blocking parts of the road and rendering it unusable for through traffic.

It is astonishing to note that while in the year 1977 all the squatter-dwellers were removed to "resettlement colonies" (Mishra and Gupta, 1981) and the city was cleared of squatters, today's Delhi is dotted with nearly 900 such squatter settlements, accommodating nearly 200,000 people.

Our inquiry as to who are the squatter-settlers revealed that only some are genuine settlers from rural areas in search of work and employment in the city. Many are from the resettlement colonies in the city itself, having given up their houses for rent or sold them, and now squatting at the site concerned.

Back on their old site, they squat with the intention of receiving free land again from the states as and when such distribution takes place. Our observations revealed that squatting is no longer an innocent act under compulsions of poverty, it is an organized and manipulated activity managed by a group of people with strong political patronage and administrative support in a bid to benefit from the government subsidies for the poor while they receive a continuous income in the form of fees for allowing the poor to build their shelters within the squatter settlement. A large number of Bangladeshi migrants settled in this squatter settlement further suggests the fact of political

patronage and interference in the system. The squatter settlement also shows a high rate of employment both for males and females. Engaged largely in the informal sector, either in the settlement itself or outside in the neighbouring colonies or factories, their popular activities are factory work, cottage household industry work, domestic work, shopkeeping and a few white collar jobs. Underworld activities ranging from pick-pocketing to commercial sex also flourish, though no one talks about them.

Under the programme for Environmental Improvement of Urban Slums (EIUS), the squatter is provided with hand-pumps and water-taps. However, the squatters have also taken additional connections direct from water-pipes meant for distribution of water for planned localities in the vicinity, which in turn face water shortage. Paved streets have not been built in a few pockets, largely because the residents refuse to remove their *jhuggis* from the site. The problem of electricity is solved by taking unauthorized connections directly from the electrical poles. A monthly sum is paid to 'someone' in the cluster itself for this illegal connection and not to the electricity board. Urban living is thus further subsidized for them.

The household possessions of squatter-dwellers may include T.V., room cooler and other items of comfort, but the walls of the house invariably are of mud, with thatched roofs and mud floor. Their investment pattern reveals that they prefer to spend either a bare minimum or nothing on items where they are sure of heavy government subsidy (like interest-free loans for building a house or provision of a land site for building a house).

Looking at the environmental degradation in the neighbouring settlements and with the aim of improving the living conditions of the squatter-dwellers, we initiated a dialogue with the dwellers for an alternative accommodation site. We were informed that the squatters were allotted an alternative site in the peripheral area of the city, but refused to shift. They wanted a site in the vicinity itself; however, there is no land available or the land values are too high for Delhi Development Authority (1991a, 1991b) to afford for squatter-dwellers. Many people live in these squatter settlements not because of "no other choice" but because of convenience. They invite political patronage and are solid vote-banks. They attract social activists who go out of their way to provide them various services like free medical aid, free education for children, work and education programmes for adolescents and women, and in cases provide creche facilities for children. Squatter-dwellers have access to several such services either through voluntary organizations or through the government-funded programmes of social welfare, for which an ordinary middle-class resident of the city has to pay through the nose.

Such sites have also become favourites for the administrators who, under the EIUS programme claim to achieve their targets of providing basic services to urban poor and in a bid to ameliorate poverty and improve quality of life, further claim a higher share of funds from the donors.

In the whole process, the beneficiary sits and smiles and muses over the fact that he has made a fool of everyone through his 'misery' because that pays him rich dividends. Otherwise, how does one explain a squatter-shelter with a wall of brick and two of tarpaulin with a shattered door of wood and with a television set, a room cooler and a two-in-one inside the hutment.

## 2. Demography and Literacy

This squatter cluster of 1510 households had a population of 6682 where 53.8 per cent are male (3595) and 46.2 per cent are female (3087), with 49 per cent (3282) in the age group 15–59, 45 per cent (2988) below 15 years and 6 per cent (412) above 59 years.

The cluster has a high rate of literacy, as 65.2 per cent of males (2108) and 34.8 per cent females (1123) are literate. The literacy level goes up with the income level of the household for males, though it fluctuates for female heads of the household (Table 1).

**Table 1. Literacy and Income–Level of the Households, Bhoomiheen J.J. Camp, New Delhi.**

Household Income level (rupees per month)	Percentage of literates to the total population (heads of the households)	
	Male	Female
500	24.3	19.5
500–999	30.5	16.2
1000–1999	31.6	17.2
2000–2999	33.4	16.7
3000 +	44.4	19.7

By education level, 48.7 per cent of the population had completed primary school education, 39.8 per cent middle school, 10.5 per cent high school and 1.0 per cent college education. Given that Hindus and Muslims account for the overwhelming majority of squatter-dwellers, religious/educational differences are small, except that only the Hindus, Sikhs and Muslims have achieved high school and college education, attained by 8 to 12 per cent of the population (Table 2).

**Table 2. Percentage of Literates, According to Religion and Education, Bhoomiheen J.J. Camp, New Delhi.**

Religion	Primary School	Middle School	High School	College Level	Total Literates
Hindu	49.1	39.0	10.8	1.1	2464
Muslim	46.1	45.4	8.2	0.4	269
Sikh	31.0	58.6	10.3	0.0	29
Christian	50.0	50.0	0.0	0.0	6
Others	33.3	66.7	0.0	0.0	36
<b>Total</b>	<b>48.7</b>	<b>39.8</b>	<b>10.5</b>	<b>1.5</b>	<b>2771</b>

Females are less educated than males and the gap between the sexes increases with the increase in the level of education (Table 3).

**Table 3. Levels of Education by Religion and Sex, Bhoomiheen J.J. Camp, New Delhi.**

Religion		Primary	Secondary	High School	College	Total
Hindu	Male	63.0	72.8	83.8	81.4	1706
	Female	37.0	27.2	16.2	18.5	758
Muslim	Male	66.1	77.9	77.3	100.0	195
	Female	33.9	22.1	22.7	0.0	74
Sikh	Male	66.7	82.4	66.7	0.0	19
	Female	33.3	17.6	33.3	0.0	10
Christian	Male	66.7	0.0	-	-	2
	Female	33.3	100.0	-	-	4
Others	Male	0.0	100.0	-	-	2
	Female	100.0	0.0	-	-	1

### 3. Income Level

The majority of the households earn Rs. 500– 2000. The maximum share is of those with an income range of Rs. 500–999, who form 48.4 per cent of the households. This is followed by Rs. 1000–1999 with 35.4 per cent of the total households. Only 8 per cent of the total households have income above Rs. 2000 per month.

**Table 4. Income Level of Households, Bhoomiheen J.J. Camp, New Delhi.**

Income Groups (Rupees per month)	Total Households	Percentage of total households
Less than 500	140	9.3
500–999	724	48.4
1000–1999	527	35.4
2000–2999	93	6.2
3000 +	26	1.7
Total	1510	100.0

#### 4. Migration

A great majority of the households (1479 of 1510) claimed that they were migrants to the city and came straight to the said settlement, the others shifting from other colonies of Delhi. But, the fact is that the majority shifted from other areas of Delhi during the early eighties. In Delhi all the squatter settlements were cleared by 1977 and were settled in resettlement colonies. But during the eighties a number of squatter settlements mushroomed all over Delhi again.

This camp has migrants from a large number of states (Table 5). Migrant households have arrived from Uttar Pradesh (542), West Bengal (186), Rajasthan (119), Bihar (84), Madhya Pradesh (33) etc. A large number of migrant households have arrived from Bangladesh (417) which are second only to Uttar Pradesh. The other states contributing to a much lesser extent to the migrant families are Orissa, Punjab, Tamil Nadu. Very few have come from southern states. Relatives (almost half), friends and sometimes contractors and middlemen form the channel of communication and partial support to the potential migrants.

**Table 5. State of Origin and Religion of Migrants to Bhoomiheen J.J. Camp, New Delhi.**

Religion	States						Others	Total
	Bihar	Madhya Pradesh	Rajasthan	Uttar Pradesh	West Bengal	Bangladesh		
Hindu	74	30	117	414	157	396	31	1219
Muslim	8	-	-	120	27	20	64	239
Sikh	-	-	-	6	-	-	1	7
Christian	-	2	2	2	2	-	-	8
Others	2	1	-	-	-	1	1	5
Total	84	33	119	542	186	417	97	1478
Scheduled Caste	30	10	33	273	63	217	8	638

Many Hindus from Bangladesh have taken shelter in India. Having crossed over the border illegally, they made their ways to Delhi either directly or indirectly. Initially, they refuse to divulge the information that they are from Bangladesh but later they confide. They claim to have possessed very small pieces of land in Bangladesh which they sold to migrate out but political instability, lack of security and poverty have made them leave their native land and take shelter in India.

Within India, most families have arrived from the nearby 15 districts of Uttar Pradesh State. They are followed by Rajasthan, Madhya Pradesh and Bihar. The majority (553)

of families speak Bengali, coming from West Bengal and Bangladesh. Most of them work in the nearby locality named Chitta Ranjan Park (they call it Bengali colony as it is largely inhabited by people from West Bengal).

There are special clusters for families migrating from different states/districts within the locality. There is a large component of scheduled caste families, as 43 per cent of the households have claimed to be scheduled caste, coming from a deprived socio-economic background.

For the migrants, it is not a step-like migration from rural to semi-urban, to small urban, large urban and the metropolitan centre. It is a straight jump for them from the rural to the metropolitan or rural/urban/metropolitan. The survey revealed that only 25 per cent were indirect migrants; others all came straight to Delhi.

The purpose of migration is well known. Employment is the basic motive behind 77 per cent of the households, though migrants gave other reasons for migration as well, like marriage (0.97 per cent) and family migration (6.7 per cent). Sixteen per cent migrated on several other counts, which seems to be quite a significant figure. Family quarrels at home force many youngsters to leave their homes. Fragmentation of land-holdings, whereby the land turns out to be highly uneconomic and incapable of supporting the family, is cited as another reason for migration.

Nearly half (48 per cent) of the migrants reported to be landless labourers at home. Many tailors migrated to Delhi because their profession provided little opportunity in their native places. The same reason has been given by the masons as well. In the city, they work in factories or shops. Migrants from Bangladesh gave the reason of migration as riots in their native places, and confiscation of their land and property which forced them out to India. The land provided to them at the resettlement sites in Purnia in Bihar or Dendkarniya in Madhya Pradesh was found to be rocky and infertile, so they left their resettlement sites and moved to Delhi.

Within the slum, a constant movement tends to take place. Those who have improved their income status tend to shift their families out, while those staying in their villages still join them from time to time. They continue to maintain their houses in the slum to help their relatives and village-folks, and also in anticipation of allotment of land/site/loan by the State to improve their housing and living conditions.

## **5. Economic Activities**

The workers engaged part-time or full-time have been classified into factory workers, domestic servants, shopkeepers, cottage and household industry workers, construction workers and others. The survey revealed that nearly 30 per cent of the population is engaged in full-time work and women form 22 per cent of the total workforce (Table 6).

There is a large concentration of men in factory jobs. The presence of Okhla industrial estates nearby provides job opportunities to the workers. Construction work is another important economic pursuit, though not common for women. Generally in construction sites, the entire family is engaged in construction work but not in this particular slum. Women have taken to lighter jobs working largely as domestic servants in the nearby residential colonies. Cottage and household industrial workers are mostly male. Women are engaged in embroidery, bead work, and other stitching and craft work,

which is brought to their houses by the male members on contract. Besides, there are a large number of women working part-time in this work, a fact which has not been brought out in this table.

**Table 6. Distribution of Workers by Job and Gender, Bhoomiheen J.J. Camp, New Delhi.**

Types of Job	Employed		No. of Persons
	Male	Female	Total
Factory workers	334	56	390
Domestic servants	55	324	379
Shopkeepers	129	9	138
Cottage & household industry workers	165	20	185
Construction workers	201	10	211
Others	634	21	655
<b>Total</b>	<b>1518</b>	<b>440</b>	<b>1958</b>

Cross-classified by income-level (Table 7), we find that most of the workers fall in the income-range of Rs. 500-1000 followed by Rs. 1000-2000. Nearly 18 per cent of the total workers have incomes below Rs. 500. Only 4.5 per cent of workers indicated their income above Rs. 2000.

**Table 7. Income Level by Nature of Work, Bhoomiheen J.J. Camp, New Delhi.**

Income groups (Rs per month)	Factory Workers	Domestic Servants	Shop-keepers	Cottage & house hold industries workers	Construction Workers	Others	Total
Less than 400	11	207	18	15	31	62	344
500-1000	201	180	115	92	171	287	1146
1000-2000	74	20	83	100	86	225	588
2000-3000	2	-	12	11	9	24	58
3000 +	-	-	2	5	-	6	13

Surprisingly, the incidence of child-labour reported in this cluster was very low. In fact, every family claimed that their children were going to schools located at walking distance. The slum itself has a community centre equipped with primary education

facilities which is used extensively by the local population. It also offers an adult education programme in the afternoon and evening shifts for women and men respectively.

## **6. Conclusion**

In brief, the analysis of the survey data dilutes many notions built around the life style of slum-dwellers. Some of the highlights may be re-emphasized.

The people here are not living out of economic compulsions, but out of choice. An alternative site proposal has not appealed to them. In fact, many of them have houses in other resettlement colonies, which they have rented out or part of their family stays there.

Their stated income may be low but it is not revealed in their consumption pattern and their life style except in the building material of the houses (which is apparently on account of other factors).

There is a class of middlemen who try to provide infrastructure like water, electricity, space for shelter in the settlement return for token charges paid periodically by the households. The middlemen themselves make arrangements for such public services by diverting them from the share of regular localities, creating sometimes an acute shortage of supply in those localities. This class of middlemen negotiates for favours to the slum/squatter residents with the politicians, non-governmental organizations, Delhi Development Authority etc., though it was stated that a large percentage share of benefits is taken away by the middlemen themselves.

The homogeneity in terms of family occupations is diffused. Men and women separately look out for the best opportunity of work whether domestic or otherwise.

A large number of NGOs and public welfare units are active in providing social services and basic infrastructural facilities to the residents. The residents are well aware of it, and take maximum possible advantage of the services rendered by the NGOs and other private/public organizations. Though education and general awareness among the people is high, the bane of slum life is still visible as a majority continue to wait for government subsidies and free services from welfare organizations.

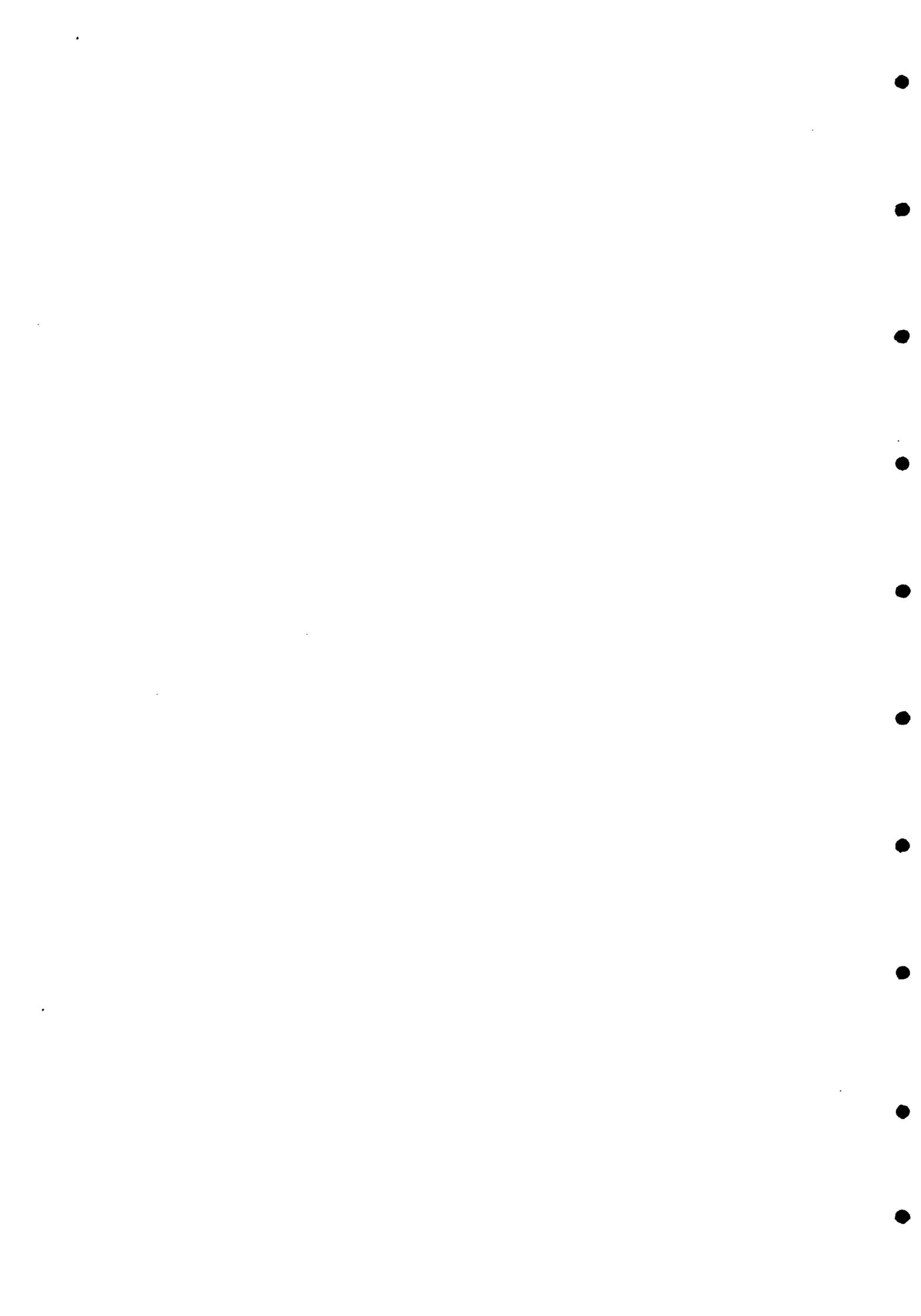
Further, the location of squatter settlements in the vicinity of planned urban colonies, the virtual encroachment on prime private/public lands, the obstruction caused to transport and commuting through the roads being cluttered with squatters' huts, shops, and other paraphernalia cause discontent among the residents of nearby localities. The general environmental deterioration in the form of open sewerage, poor drainage, waste water flowing through the streets, poor cleaning of the roads, and garbage strewn in heaps add further to the agony of the neighbours. The use of such squatters as 'vote banks' and safe pockets' to procure funds from donor agencies under the EIUS scheme further aggravates frustration among the residents of neighbouring planned localities. In this process, not only the physical environment but also the social environment faces tension and degradation.

No doubt, the poor areas and the poor people need subsidies for survival in metropolitan cities. However, where both 'donor' and the 'target-group' take undue

advantage of the subsidies being made available in the name of the urban poor, there arises a need to recast the strategies of development.

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## CHAPTER 19

# HOW MIGRANTS PERCEIVE ENVIRONMENTAL CONDITIONS: A CASE STUDY IN JAKARTA, BOGOR, TANGERANG AND BEKASI, INDONESIA<sup>1</sup>

by

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### 1. Industrialization and Rural-Urban Migration

As a developing country, Indonesia is engaged vigorously in nation-building activities. Since 1969/1970, the nation implemented five-year development programs. It is in the beginning of the sixth Five-year Plan (1994-1999). Programs and projects undertaken during the preceding 25 years (the first long-term plan) produced records of progress. The nation's per capita income rose. Its economic structure shifted from one heavily based on agriculture to one characterized by industries.

Indonesia achieved not only advancements but also encountered a number of challenges. The latter include inequalities and discrepancies in regional development. A striking discrepancy occurs between rural and urban growths. Industrialization, concentrated in the urban areas, attracted migration of people from the villages to the cities.

Developing countries frequently apply the macro approach (known sometimes as the Chenery-Syrquin approach) when dealing with issues on national development programs and projects. Generally, developing countries follow a pattern of development which shows that at a certain point a developing country enters a process of industrialization.

Indonesia is not excluded from the phenomenon. Since 1991, statistics on national income, based on prevailing or constant prices, showed that contributions by the manufacturing sector to the country's gross national product exceeded contributions by the agricultural sector. Since 1990, prevailing prices showed that the manufacturing contributed in excess of 20 per cent to the gross national product. This means that Indonesia can be classified as semi-industrialized country.

Concurrent with the process of industrialization, there occur changes in the nation's population structure and shifts in population growth, fertility, infant mortality and migration. There is a close relationship between industrialization in urban areas and the migration of people from rural regions to urban neighborhoods. Limited employment opportunities and low incomes in rural regions prompted young people from the villages to migrate to centers of industry in urban areas. Large-scale industrialization in urban areas drew people from the villages and created the flow of people from the

villages to the cities generating high demands for social and health facilities. However, migration occurs faster than the delivery of such facilities. It takes time to provide social and health facilities and the costs incurred are substantial. Consequently, slums areas sprout up in neighborhoods where the migrants live. The slums are the best alternative for migrants who, due to their incomes, cannot afford to live elsewhere<sup>2</sup>. Such environments are assumed to affect their health.

Conditions such as the aforementioned are readily seen in areas where industries locate, especially in the Jakarta, Bogor, Tangerang and Bekasi areas, hereinafter referred to as JABOTABEK. This region, where large industries concentrate, is highly attractive to migrants. This paper proposes to review conditions in this area and present the migrants' perceptions of environmental conditions in JABOTABEK.

## **2. Greater Jakarta, an Industrial Region and a Destination Point for Migrants**

Jakarta, the capital of Indonesia, is the center of economic and trade activities, the center of government and the concentration point for industries. A large number of migrants from rural regions descend on this metropolitan area. They come from all over Indonesia. The in-flow of migrants and high fertility among city dwellers generated a high population growth in JABOTABEK.

Between 1980 and 1990, Jakarta experienced a slight decline, about 2.41 per cent, in population growth. During the same period, its population increased from 6.5 million in 1980 to 8.2 million ten years later (Central Bureau of Statistics, 1991). It is projected that in the year 2005, the capital city will be inhabited by 11.3 million people (Demographic Institute, Faculty of Economics, University of Indonesia, 1992).

In anticipation of projected population growths, the government of Jakarta has long strived to discourage people from moving to and resettling in the metropolitan area. Measures for controlling population growths are pursued through, among others, family planning. Measures for controlling population distribution called for, among others, opening of residential neighborhoods and creation of jobs in Bogor, Tangerang and Bekasi. Presidential Decree No. 13/1976 on Growth in Greater Jakarta paved the way for the opening of residential areas and creation of jobs in the fringe areas of the capital city, seeking to reduce population pressure on Jakarta. The residential areas in Bogor, Tangerang and Bekasi encouraged people to relocate from the capital city to those suburbs. Available data show that migration from Jakarta to the adjoining municipalities exceeds the in-flow of people to the capital city. West Java absorbs most of the migration; it accommodated 538,381 new settlers in Bogor, Tangerang and Bekasi at the time of the 1990 population census.

The foregoing showed that although migration to Greater Jakarta remains substantial, its impacts on the capital city have declined. On the other hand, migration from Jakarta to the suburban areas appears to increase (See Table 1). The 1990 population census unveiled that 38.5 per cent of Jakarta's inhabitants are life-time migrants, a decline from the 40.1 per cent recorded in 1980. Table 1 also shows significant increases in the percentage of migration from Jakarta to the neighbouring areas. In 1980, migration from the capital city was 6.2 per cent; it rose sharply to 12.8 per cent ten years later.

The increased migration from Jakarta occurred concurrent with the rising inflows of people to West Java, from 3.7 per cent in 1980 to 6.8 per cent a decade later. The foregoing can be interpreted to mean that people who moved out of the capital city generally headed for West Java, specifically to settlements in Bogor, Tangerang and Bekasi.

Presumably, the sizeable relocation of Jakarta residents to Bogor, Tangerang and Bekasi resulted from the availability of housing obtained through the National Housing Authority, mortgages secured from Bank Tabungan Negara (State Savings Bank), commercial loans and the ministries which employ the migrants. Available data show that until the end of 1990, the National Housing Authority built 56,352 housing units in Bogor, Tangerang and Bekasi accounting for 69.8 per cent of the houses the Authority built in West Java.

Houses in the three municipalities are built not only by the National Housing Authority but also by private residential developers. Available data show that housing construction in Bogor, Tangerang and Bekasi increases every year. In 1986, private developers accounted for 65.69 per cent of the housing construction in the three areas; the percentage rose to 73.5 and 76.1 in 1989 and 1990 respectively.

Population redistribution to Bogor, Tangerang and Bekasi occurs concurrently with construction of industries in the three areas. The new industries are built to increase employment opportunities for people residing in Jakarta's fringe areas. Thereby, population concentration in the capital city can be reduced.

The sizeable number of people who move out to Bogor, Tangerang and Bekasi is expected to ease population pressure on the capital city. Densely populated neighborhoods at centers of activity in the capital city are gradually experiencing relief after the departure of their residents to Bogor, Tangerang and Bekasi. Housing construction in the three municipalities during the past decade has effectively eased population density in Jakarta. Unfortunately, low-income people find it impossible to obtain houses because they cannot afford the increasing amounts of down payments and monthly instalments. If this condition persists, then the new houses built in the three districts will be unable to reduce population density in Jakarta's slum neighborhoods.

A sizeable number of Jakarta residents have resettled in Bogor, Tangerang and Bekasi but continue to commute daily to their jobs in the capital city, and also to pursue education and attend to other personal business. A survey undertaken by the Jakarta Statistics Bureau revealed that most of the commuters descend on Jakarta daily because of their jobs. Of the 2,500 households surveyed, 54 per cent worked in Jakarta. Of the respondents in Bekasi, 60 per cent worked in Jakarta and only 38 per cent maintained jobs in the district domicile. Therefore, only a small portion of Bekasi residents worked close to their homes. The same occurred in Tangerang where only 43 per cent of the respondents worked in the district while 55 per cent worked in the capital city.

A sizeable number of people from Bogor, Tangerang and Bekasi attend schools in Jakarta. Approximately 46 per cent of the residents under 10 years of age commute to their schools in Jakarta. Of the Bogor respondents, only 47.5 per cent attend local schools while 52 per cent commute to Jakarta. The larger percentage is presumed to have been caused by the large number of people who live in the districts of Bogor

Regency, such as Depok, Cisalak and Cimanggis which are closer to schools in the capital city.

The above data endorse the prevailing opinion that population migration from Jakarta to the suburban regions is not accompanied by sufficient relocation of jobs, schools, health services, recreation and other facilities. Those who moved out to the suburbs continue to patronize facilities provided by the metropolitan city. Consequently, those who work and attend schools in Jakarta commute daily from Bogor, Tangerang and Bekasi.

**Table 1. Lifetime Migration (in and out) as Percentage of the Total Population of each Province in Indonesia, in 1971, 1980, and 1990**

PROVINCE	IN-MIGRATION			OUT-MIGRATION			TOTAL POPULATION		
	1971	1980	1990	1971	1980	1990	1971	1980	1990
D. I. Aceh	3.08	5.60	5.70	3.28	4.44	3.68	2,008,341	2,610,528	3,415,674
North Sumatra	8.27	6.84	4.48	2.84	5.00	7.51	6,620,811	8,350,950	10,252,311
West Sumatra	3.18	3.95	5.45	11.64	16.41	16.07	2,792,221	3,406,132	3,998,764
Riau	13.23	16.46	21.02	2.54	4.00	3.89	1,641,074	2,163,896	3,278,807
Jambi	15.91	20.66	23.46	2.73	3.26	3.83	1,005,658	1,444,476	2,018,463
South Sumatra	9.71	13.35	14.84	5.79	7.20	7.03	3,438,061	4,627,719	6,311,958
Bengkulu	7.01	15.99	21.34	4.77	5.08	3.96	519,316	767,988	1,178,951
Lampung	36.15	38.78	28.77	1.07	1.25	2.79	2,775,695	4,624,238	6,015,803
DKI Jakarta	40.07	40.11	38.53	2.91	6.18	12.79	4,546,492	6,480,654	8,227,746
West Java	1.77	3.66	6.81	5.52	5.42	4.95	21,620,950	27,449,840	35,381,682
Central Java	1.19	1.38	1.81	8.22	12.72	15.87	21,865,263	25,367,344	28,515,737
D.I. Yogyakarta	4.07	6.56	9.15	10.73	9.22	17.45	2,488,544	2,750,128	2,912,611
East Java	1.17	1.60	1.77	2.94	5.48	7.63	25,508,387	29,169,004	32,487,744
Bali	1.07	2.64	4.14	2.69	4.77	7.98	2,120,091	2,469,724	2,777,356
West Nusa Tenggara	1.55	2.06	2.06	0.58	1.63	2.87	2,203,435	2,723,678	3,368,699
East Nusa Tenggara	0.57	1.56	1.47	1.14	1.74	3.04	2,295,279	2,736,988	3,267,919
East - Timor	-	-	6.25	-	-	1.71	-	-	747,557
West Kalimantan	1.21	4.52	6.19	1.74	2.91	3.62	2,019,924	2,484,891	3,228,073
Central Kalimantan	7.16	14.91	17.28	1.64	2.63	3.42	701,936	954,176	1,396,013
South Kalimantan	3.96	7.05	10.58	4.96	8.22	7.78	1,699,105	2,063,227	2,596,647
East Kalimantan	5.58	24.45	32.24	3.24	2.80	3.39	731,606	1,214,602	1,875,032
North Sulawesi	2.93	4.32	3.60	3.54	5.73	6.20	1,717,671	2,114,822	2,477,189
Central Sulawesi	5.62	14.56	16.88	3.75	2.64	2.84	913,662	1,284,528	1,703,330
South Sulawesi	1.38	1.96	3.23	4.67	8.44	9.20	5,179,911	6,059,564	6,980,589
South-East Sulawesi	3.64	11.26	17.61	4.31	9.55	7.98	714,120	941,634	1,349,298
Maluku	4.00	9.24	10.08	3.36	4.60	5.15	1,089,511	1,408,451	1,852,723
Irian Jaya	22.50	8.68	16.13	4.28	1.40	1.89	150,786	1,107,291	1,630,107
Abroad	-	-	-	-	-	-	-	-	-
Not-Known	-	-	-	-	-	-	-	-	-
<b>TOTAL</b>	<b>4.94</b>	<b>6.97</b>	<b>8.25</b>	<b>4.94</b>	<b>6.97</b>	<b>8.25</b>	<b>118,367,850</b>	<b>146,776,473</b>	<b>179,247,783</b>

Sources: Indonesia, CBS., 1975. Population of Indonesia, Result of The Census 1971, Serie D, Table 23  
 Indonesia, CBS., 1983. Population of Indonesia, Result of The Census 1980, Serie S No. 2, Table 06.3  
 Indonesia, CBS., 1992. Population of Indonesia, Result of The Census 1990, Serie S No. 2, Table 08.9

The high population mobility in Greater Jakarta has environmental impacts unique to the region. While population pressure shifts from Jakarta to the suburbs, patronage of public facilities in the capital city remains as high as ever creating congestions on roads which connect Jakarta to Bogor, Tangerang and Bekasi. A study undertaken by the Demographic Institute showed that traffic congestion was the main problem encountered by 86.8 per cent of its 682 respondents. Of the commuters from Depok and Bekasi, 91.9 per cent and 91.5 per cent respectively complained about traffic congestions.

The high population mobility and the sizeable number of migrants to Jakarta created serious impacts on the area's environment. It is therefore necessary to know the attitudes and behaviors of the migrants towards the environment in Jakarta and why people migrate from Jakarta.

### 3. Why People Migrate

The reasons why people relocated to Bogor, Tangerang and Bekasi from Jakarta differ from the reasons why people migrated to the three areas from other regions of the country. Generally, former residents of Jakarta resettled in Bogor, Tangerang and Bekasi because they found suitable houses. People from other regions of the country migrated to the three districts because of employment.

Two studies conducted by the Demographic Institute showed that 56 per cent of the 400 respondent heads of households decided to move to either Bogor, Tangerang or Bekasi after obtaining mortgages from the State Savings Bank. This means that rapid growths in housing at affordable prices provided the pull factors for relocation from Jakarta to Bogor, Tangerang and Bekasi. The push factors varied and ranged from respondents' efforts at escaping from environmental interferences (7.5 per cent), high costs of living in Jakarta (7.8 per cent), high costs of real estate in Jakarta (9.7 per cent) and so forth. It is interesting to note that only 3 per cent of the respondents relocated because they wanted to be close to their jobs.

The above findings lead us to suspect that the newly-developed industrial centers in Bogor, Tangerang and Bekasi do not provide the pull factors for people to move out of Jakarta and live in the three districts. They merely delay migration from other regions of the country to the capital city.

The industrial centers in Bogor, Tangerang and Bekasi attract the flows of migration which originally headed for the capital city. Another study by the Demographic Institute showed that 66 per cent of the 277 respondent migrants from areas other than Greater Jakarta (based on lifetime migration) said they migrated to this area for reasons of employment. Available data showed that employment was the main reason why migrants left their home towns in other parts of the country and settled in Bogor, Tangerang and Bekasi. The above findings endorsed the prevailing assumption that industrialization in Bogor, Tangerang and Bekasi provides the incentives for people to relocate to and work in the three districts. Wages in these industrial zones are higher than wages in rural farms and therefore encouraged the rural-to-urban migration. The respondents earned an average monthly salary of Rp. 163,000 from the main occupations. Those with side jobs earned up to an average of Rp. 249,000 a month.

The preceding descriptions revealed that housing and industries in Bogor, Tangerang and Bekasi attracted people to migrate to these areas from other regions of the country. Housing construction in Bogor, Tangerang and Bekasi also attracted people from the capital city. Meanwhile, industries in Bogor, Tangerang and Bekasi drew a sizeable number of migrants not only from the other regions of the country but also from metropolitan Jakarta. In the long run, these migrants apply pressure on the environments of the three districts.

#### **4. Environmental and Residential Conditions**

Employment is a major reason for people to migrate from the various regions of the country to Bogor, Tangerang and Bekasi. People migrated either because they were unable to find jobs in the villages or because jobs in urban areas were better than jobs in rural regions. Their successes in finding employment, however, did not necessarily ensure that they could live in decent houses and in good neighborhoods. For reasons of efficiency and economy, they were willing to live in relatively run-down neighborhoods as long as they could be close to their places of work. This is understandable; housing in urban neighborhoods is expensive and is inaccessible to those in the low-income group.

Descriptions of the environment in which respondents resided are based on observations of neighborhoods near and around industrial centers. The recent migrants generally rent or share leases on houses or rooms in neighborhoods near their places of employment. Only a few of them owned homes. The study revealed that 67 per cent of the respondents rented houses or rooms and only 32 per cent owned homes. The rentals or leases were adjusted to their incomes; the average monthly rental was Rp. 39,300.

Of the respondents, 88 per cent drew their drinking water from wells. Similarly, water for bathing and laundry was drawn from the same well. Generally, respondent households drew water from the same well to meet their needs for drinking, bathing, household cleansing and other purposes. Most of the respondents shared common facilities for bathing and washing their clothes. Only 39.4 per cent of the respondent households had private bathrooms and laundry facilities.

Few of the drains or sewers which carried domestic waste water were in good condition. The study uncovered that 39.4 per cent of the drains or sewers were clogged and 12 per cent of the respondent households had no sewers to which they could drain their domestic wastewater. Most of the respondent households buried or burned their domestic solid waste or trash. Only 10 per cent had trash pickups and 8 per cent disposed their trash in nearby canals or sewers. Respondents complained that these methods of disposing domestic wastewater and solid wastes created pollution of their neighborhoods. The situation was aggravated by the close proximities of their houses to factories. Of the 99 respondent households, 76 per cent complained their neighborhoods were polluted while 24 per cent said their neighborhoods were free of pollution. A sizeable number of the respondents complained of environmental pollution generated by smoke, noises from factory machinery and motor vehicles as well as unpleasant odours.

The migrants therefore generally lived in neighborhoods with adverse physical and environmental conditions, attributable to the spaces in which they lived, the sources of water, disposal of domestic wastewater and other interferences from the surrounding environs.

## **5. How Migrants Perceived their Environment**

It is important to know how people perceive their environment and environmental issues. This is especially true in a metropolitan area such as Jakarta. The city is inhabited by people from all parts of the country who live in all social strata. Some of the behavioral attitudes they brought from their home regions may not necessarily be good for and acceptable in Jakarta.

Descriptions on migrants' perceptions are based on findings of a study by the Demographic Institute on 682 commuters who lived in Bogor, Tangerang and Bekasi. They were asked about the various environmental occurrences in their neighborhoods. There is a sizeable number of migrants who live in Bogor, Tangerang and Bekasi and their mobility is sufficiently high. Were there any relationships between the migrants' attitudes and behaviors toward the environment and the environmental conditions of their neighborhoods? What were their attitudes toward environmental matters and behaviors in their environment?

Respondents' knowledge of environmental issues undoubtedly have a bearing on the formation of their attitudes toward the environment. Respondents who are knowledgeable about and adopt positive attitudes toward the environment are presumed to adopt a more favorable attitude toward environmental matters. Knowledge of environmental affairs is obtained from varied sources such as schools, the mass media, books and so forth.

This study presents some of the sources where respondents obtained information on the environment. Most of the respondents, 94.7 per cent, knew about environmental issues from the mass media; 64.1 per cent learned from household members while 57.6 per cent were informed by friends or relatives. The preceding findings can be interpreted to mean that the mass media assume a significant role in forming respondents' awareness of and attitudes towards the environment. It was encouraging to note that respondents' household members were placed second on the roster of sources of information on environmental issues and therefore, significantly instrumental in forming respondents' attitudes towards the environment.

Respondents' attitudes were also moulded by environmental facts or incidents which they saw or experienced. Respondents who knew or witnessed many negative environmental occurrences were moulded accordingly on their attitudes toward the environment. However, this study showed that respondents had positive attitudes towards the environment. Of the respondents, 95 per cent said the many negative environmental incidents they heard or saw in Jakarta had adverse effects on the metropolitan area. None of the respondents favored indiscriminate disposal of solid wastes. However, some of them, 0.4 per cent, stated that indiscriminate disposal of trash was "reasonable". Those who maintained this attitude resided in neighborhoods without trash bins or in areas without trash collections. In these neighborhoods, each

household disposed its trash in its own convenient way, either by burying or burning them.

Of the respondents, only 2.5 per cent said that smoking in public places or public transportation was "reasonable" and 2.1 per cent said it was good. These respondents said that smoking in such places helped reduce smokers' restlessness during their journeys. In contrast 95.4 per cent of the respondents were against smoking in public places or buses. Those who said so maintained that the smoke from the cigarettes was detrimental to people around the smokers. Furthermore, they claimed, an undue amount of smoke from cigarettes might interfere with the operator's capacity to drive his vehicle.

A sizeable number of residents remain unaware of the dangers created by motorists who drive with excessive speeds, create undue noises and exhausts from their vehicles. The foregoing surfaced from respondents who said that speeding was "good". Their percentage, however, was only 2.9. The other respondents, 97.2 percent, said that speeding was "bad".

Respondents were asked to comment on the various infringements on the environment. They agreed that sanctions should be imposed on those who violated environmental laws and regulations. The number who maintained this position was sizeable. Although 95.4 per cent of respondents disapproved of smoking in public places, only 63.3 per cent of this group agreed to impositions of sanctions against those who smoked in public places. These findings showed that efforts at establishing a sound environment, including campaigns against smoking, should be pursued through punitive measures rather than mere appeals against smoking. Thus, thought should be given to the types of sanctions to be imposed on the various types of infringements against the environment.

This study also uncovered the various forms of sanctions respondents recommended against violations of environmental laws. Respondents were against prison terms. Only a small percentage of the respondents favored such punitive actions. Many respondents suggested prison terms only for those found guilty of speeding and those found guilty of relieving themselves at inappropriate places. Respondents recommended a number of punishments for those found guilty of smoking in public places and for indiscriminate disposal of solid wastes. They ranged from a mere warning to physical punishments such as sit-ups, push-ups and so forth. Most of the respondents recommended fines for those found guilty of violating environmental laws. This can be interpreted to mean that respondents favored levies of environmental taxes, particularly against those who committed major crimes against the environment.

This study also revealed respondents' willingness and refusal to take part in environmental management programs. Most of them preferred to take part in environmental programs on their neighborhoods rather than in public places or facilities. There were respondents who flatly refused to become involved in environmental programs on public facilities. Respondents recommended various forms of involvement in environmental management programs. There were those who wanted to contribute financially and those who agreed to contribute their time and labor. There were also those who wanted to contribute their money and energy.

Generally therefore the people are truly willing to help out if they are recruited to take part in environmental management programs. Thus, the question is not one of an

agreement or a disagreement but rather on how they are approached and asked to take part and create a positive behavior toward the environment.

The preceding descriptions on respondents' perceptions of the environment indicated the people's intense desire to create a clean and compatible environment. Migrants lived in slum areas because of their economic and other structural conditions rather than because they had no cultural appreciation and awareness of a good environment. Their socio-economic conditions forced them to live in slum neighborhoods.

## **6. Policy Implications**

Traffic congestions in Greater Jakarta are serious problems faced daily by the people. The available means of public transportation are inadequate to move people inside and outside Jakarta. Motor vehicles which are stuck in traffic congestions created air pollution through excessive exhausts of carbon dioxide (CO<sub>2</sub>). Traffic congestions are strenuous on people in transit; fatigue and weariness strike those who travel frequently in the city.

Therefore, it is necessary to create options on urban transportation in Jakarta. To date, most of the people travel by bus, taxi and the like; few of them ride the train. A study conducted by the Demographic Institute showed that only 8.4 per cent travelled by train to their jobs in the city. The low percentage of commuters by train indicated that the railways remain unable to facilitate travel in Greater Jakarta. Transportation in Greater Jakarta demands immediate overhauls to reduce commuter traffic on the environment.

Workers in industrial centers remain without adequate housing amenities. This also requires serious attention. The workers earn low wages; consequently, they are only able to live in cheap houses in slum areas. Their neighborhoods are densely populated and their homes stand too close to one another. These conditions frequently affect their health. Overcrowding in these neighborhoods makes the environs more unfavorable.

Consequently, it is necessary to build houses close to industrial centers. In other words, plans for industrial centers must incorporate plans for employee housing. Unless the two are integrated, the sizeable numbers of workers will interfere with environmental conditions in neighborhoods adjoining the industrial centers.

Attention is also focused on efforts at enhancing public awareness of the environment. Generally, people are sufficiently aware of conditions in their neighborhoods. However, such an awareness is confined to individual homeowners. Public awareness of the general environment needs to be upgraded. Efforts at increasing environmental awareness should be carried out intensively through relevant campaigns. Thereby, the people are truly involved in voluntary campaigns on environmental preservation in Greater Jakarta.

## Footnotes

<sup>1</sup>This paper consolidates the findings of two studies undertaken by the Demographic Institute, Faculty of Economics, University of Indonesia. The first study focused on industrialization, urbanization and their impacts on the health of people in urban neighborhoods. The second study deals with the attitudes and behaviors of people in the Bogor, Tangerang and Bekasi suburbs towards the living environment in metropolitan Jakarta, the capital of Indonesia. Data from the two studies are excerpted to strengthen this paper. Since this paper discusses cases, therefore, its descriptions and conclusions cannot be generally applied to reflect conditions throughout Indonesia.

<sup>2</sup>Wages in developing countries are generally low and provide a comparative advantage to efforts at attracting industries from developed countries. Studies on the wage profiles of factory workers in Indonesia show that the minimum wages prescribed for workers remain low and are unable to meet the minimum requirements of their physical needs.

**PART IV**

**SOME POPULATION-ENVIRONMENT-DEVELOPMENT  
PROBLEMS**



## CHAPTER 20

# RURAL POPULATION SETTLEMENTS AND THE ENVIRONMENT IN CENTRAL SUDAN

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Central Sudan exhibits an unusual heterogeneity of rural population settlements. They reflect a complex of economic, tribal, religious and political factors. This chapter examines population settlement patterns and their relationship to the environment of central Sudan. It highlights land, water and biomass fuels (wood, charcoal, agricultural residues and animal waste) as major factors in population settlement patterns and environment interaction. Section 1 of the chapter gives a brief description of the environment of central Sudan. Section 2 focuses on population dynamics and settlements. It starts with a brief account of population dynamics of central Sudan and considers the adaptation of nomadic tribes to the environment. Subsequently the section discusses new patterns of rural population settlements that have emerged as a result of agricultural development; particularly population settlements in villages and small urban centers in the irrigated and mechanized rainfed agricultural schemes. Section 3 presents the role of the government, and section 4 highlights the role of agricultural development policies in social change. In section 5 the chapter focusses on biomass fuel resources and consumption by various population settlements. The chapter concludes in section 6 where final remarks are discussed.

### 1. Environment of Central Sudan

Central Sudan lies immediately to the south of Khartoum and is dominated by what is currently known as the central state (Fig. 1). This area constitutes about 9 per cent of the total land area of the Sudan (Table 1). It is naturally divided to three major sections:

- (a) Al-Gezira which lies to the south of Khartoum between the Blue Nile and the White Nile rivers. The eastern side of the Blue Nile river often is added to the main Gezira land to constitute one administrative unit.
- (b) The White Nile which lies to the west of Al-Gezira and is physically dominated by the White Nile river. The northern part of this section is dry with very little rainfall. Agricultural pump schemes are located on both banks of the river.
- (c) The Blue Nile which lies to the south of Al-Gezira and extends to the international borders with Eritrea and Ethiopia. Rainfall (500mm to 1000mm) is considerably higher in this section, allowing for more pasture for animals and rainfed cultivation.

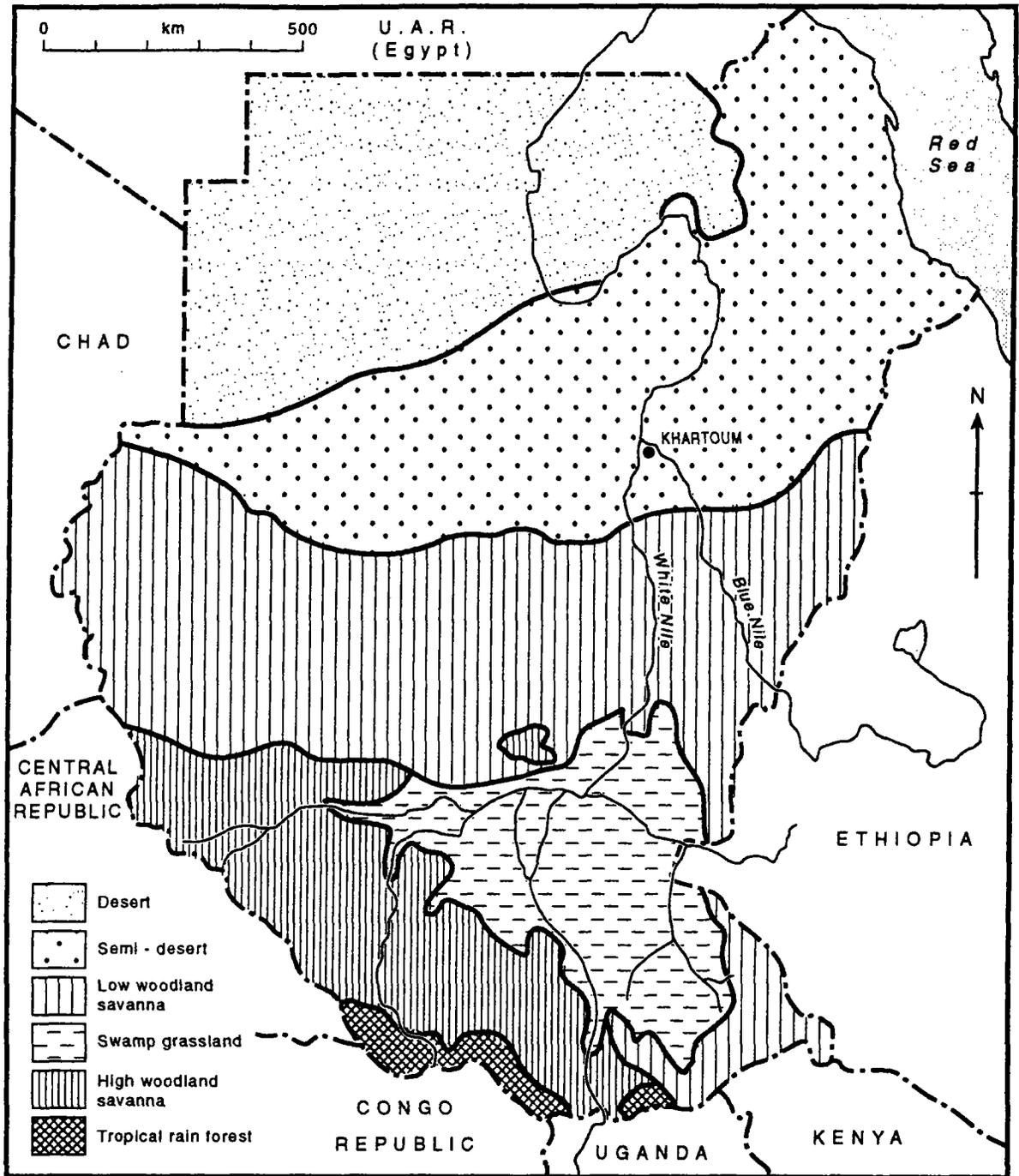


Fig. 1. Main ecological zones and average rainfall in Sudan.

**Table 1. Environment of Central Sudan**

Variable	Description
Area	139017km <sup>2</sup> extending between latitudes 9.30 and 15.30 and longitudes 31.50 and 35.30. This area is divided into three major sections (1) Al-Gezira, (2) White Nile and (3) Blue Nile
Rainfall	Ranges from 300 mm in the north to 1000mm in the south (July – October). High seasonality and low degree of reliability in sustaining natural and cultivated plants
Soil	Very heavy dark cracking clay. Flat plain sloping very gently to the west and north.
Sources of Water	Rivers: Blue Nile and White Nile rivers. Seasonal tributaries: Rahad and Dindir Hafirs and boreholes.
Population	5.5 million persons in 1993. 73 per cent rural settled, 21 per cent urban and 6 per cent Nomadic Population density 38.9 per m <sup>2</sup>
Economy	Three farming systems: 1. Irrigated farming, 2. Mechanized rainfed farming 3. Traditional farming including livestock raising. Several industrial plants (sugar, textile, oil seeds and food industries).
Energy	Central Sudan is the major producer of energy in the country in the form of hydroelectric power and biomass fuels.

### 1.1 Land

The most striking features of land in central Sudan are its high fertility, flatness and gentle slope to the west and north. The soil consists of heavy dark clay. There is uniformity in the type and quality of land and hence of crops produced: cotton, wheat, sorghum (*dura*), sesame, groundnut and vegetables. With unreliable rainfall in northern Gezira and the White Nile, pasture and rainfed cultivation are very limited. By contrast, the amount of rainfall in the Blue Nile permits land use for rainfed cultivation and grazing. The natural vegetation consists of stands of *Sunt* (*Acacia arabica*) in the savannah woodland belt. To the north of this belt shrubs and thorn trees are scattered. Vegetation becomes very scarce as you move north close to Khartoum.

## 1.2 Water

Use of land for cultivation and pasture is conditioned by availability of water. Before inception of the irrigated agriculture schemes, wells and surface water tanks were popular. Wells reach water some 100 feet below the surface and were, therefore, of limited use for irrigation. Surface tanks, on the other hand, were too few and were used for drinking water and not for irrigation (Barbour, 1961).

The gentle slope of land to the north permitted gravity irrigation. This started with construction of Sennar dam and establishment of Al-Gezira scheme in 1925. Subsequently, Jabal al Awlia dam was constructed in 1937 to store water and guarantee its permanent flow for agriculture in Egypt and Al Roseries dam in 1966, allowing for excavation of hundreds of miles of irrigation canals extending on both sides of rivers. These canals are now an important source of water for cultivation (Table 2) and for domestic use by rural inhabitants but it has also been argued that they created habitats for snail breeding that helped in the spread of water associated diseases such as malaria, bilharzia and schistosomiasis (Shaaeldin, 1980). Moreover, the Rural Water Development Corporation excavated *hafirs* (surface water reservoirs) and boreholes for use by nomadic tribes and rural sedentary population.

**Table 2. Irrigated Schemes in Central Sudan**

Scheme	Area (thousand feddams)
Al-Gezira	2000
Al-Rahad	300
Blue Nile Pump Schemes	616
White Nile Pump Schemes	620
Al-Suki	85
Kenana	80
Assalaya	37
Al-Gunied	80
Sennar West	32
Abu Na'ama	30
<b>Total</b>	<b>3880</b>

(1 feddan=1.038 acres)

Source: Ministry of Agriculture, 1990.

## **2. Population Dynamics and Settlements**

### **2.1 Population Dynamics**

Data on population dynamics indicate that the size of the population of central Sudan has increased from 2.1 million persons in 1956 to 5.5 in 1993, more than doubling in about 37 years. This implies a rapid growth rate of about 2.6 per cent per year. The 1956 urban population has grown five times by 1993, as compared to only two times for both of the rural and nomadic populations.

In view of these high rates of growth the population is undoubtedly young. A significant proportion (45 per cent) of the population is under 15 years of age, and less than 5 per cent are 65 years and above. Also, 44 per cent of all women are in the reproductive age span 15 to 49. This imply a high potential for reproduction. Those who are in the working age group 15 to 64 constitute 53 per cent of the population; not all of them economically productive. The dependency burden is exceptionally high at a rate of 97 per cent.

Nuptiality and fertility are the most important pillars of the reproductive system and family formation. Marriage in the Sudan has traditionally served to further childbearing and strengthening of women's reproductive status. Infertility and out-of-wedlock births are considered socially unacceptable. Fertility in central Sudan is high: the crude birth rate is 45, the total fertility rate is 6.7 and the general fertility rate is 198.

A study by Henin (1968) unravelled enormous fertility differences between rural population groups:

1. A well known group of people settled in Al-Gezira scheme had a total fertility rate of about 8.2.
2. Two partly settled populations in Al-Managil and Al-Mujlad had total fertility rates of about 6.7 and 4.6 respectively.
3. Two population groups practising nomadism (Blue Nile nomads and the Baggara) had identical rates of 3.6.

Henin (1968) attributes these differences to four factors: (1) childlessness is higher among the nomads compared to the settled population; (2) the mean age at first marriage is different between the three population groups; it is higher for the nomads as compared to the sedentary population; (3) high marital instability among the nomads; and (4) high incidence of miscarriage among the nomads. More recent findings from the Sudan Fertility Survey and the Sudan Demographic and Health Survey give higher fertility rates for the irrigated schemes where people are settled in villages, as compared to other parts of the Sudan.

### **2.2 Nomadic Population**

Central Sudan is inhabited by groups of well-known nomadic tribes such as the Kawahla, Rufaa Al-Hoi, Kenana, Fulani and Hassania. Each tribe and its subgroups is attached to a particular area of land and has the exclusive right to exploit it. Families

and kin-groups can claim any piece of land lying within the jurisdiction of its tribe. Therefore, nomadic tribes use land in accordance with their tribal customs or as the tribal authority directs (Ahmed, 1976).

The social structure of nomadic tribes is patrilineal with distinct dominance of males. Males marry within their kinship groups so as to maintain the solidarity of their families. Members of each kinship group work according to traditionally accepted principles of division of labor. The whole sub-tribe shows complete solidarity when a feud breaks out over water and land for grazing and cultivation.

Nomads live in tents easy to dismantle whenever they decide to move. Tent clusters consist of closely related households. A tent cluster may consist of 10 to 15 households, depending on the water and grazing conditions of the area. Tent clusters close to each other constitute a *ferig* (five to six clusters of tents). Each nomadic *ferig* often is under the leadership of one *sheikh*.

The central area of Sudan provides a wide variety of pastures that nomads' animals need. Camels exist entirely on shrubs and trees. Cattle and sheep live on grasses, seed pods and shrubs. Nomads practise various grazing techniques. For example, Rufaa Al-Hoi and Kenana tribes practise light grazing (while on the move), and the Fulani pastoralist practise razor grazing (leaving no grass behind) (Ahmed, 1976).

Nomads in Sudan usually move in the north-south directions. The northward movement, which often commences with the rain, is a long distance migration. The southward movement is a short distance migration. Usually they move in family units. In the wet season animals and families move within a close distance to each other. In the dry season the two are usually separated by a long distance.

### 2.3 Rural Settled Population

Irrigated and mechanized rainfed agriculture projects are a prominent feature of development plans laid out for the Sudan by various governments. The main aims of these projects are:

- a. To utilize the vast expanse of land in central Sudan by introducing modern methods of irrigation and improving farming principles and by using tractors where cultivation is based on rainfall.
- b. To induce rural people to settle in permanent villages where they can receive social services and can easily be integrated in the development process.

The great majority of the irrigated schemes are located in the central state. An area of approximately 3.9 million feddans is under irrigation by canals stretching from dams and large pump machines located on the Blue Nile and the White Nile rivers (Table 2). This expansive agriculture has brought about a new pattern of population settlements and distribution in central Sudan. Five major categories of population settlements can be identified depending on tribal affiliation and a different combination of associated land and water uses.

#### (a) Nile Villages

The oldest and most well-known population settlements in central Sudan are the large villages located close to the banks of the Blue Nile and the White Nile rivers. Most of them are connected by asphalt and paved roads and railways to towns and cities such as Khartoum, Wadmedani, Sennar, Kosti and Senga. Some of these villages are well known religious sites where famous religious leaders and their followers live. People living in these villages consist of groups of families descending from the same great grandfather. Such kinship groups usually consist of about 20 families. Therefore, a village settlement of 2000 persons will consist of about 100 kinship groups.

#### (b) Tenant Farmer Village Settlements

These are medium-size villages located 50 to 100km away from the banks of rivers and are scattered on the clay plains of the irrigated agriculture schemes. There are, for example, about 1550 villages in Al-Gezira scheme, 68 villages in Al-Rahad scheme and 80 villages in Al-Suki scheme. Most of the inhabitants of these villages are tenant farmers and their families. Most of them are Arabs and few are Sudanese westerners and *fellata* (Sudanese of West African origin, particularly Nigerians). They have access to water either from a borehole or from irrigation canals. Inhabitants of these villages have access to education and primary health care services. These villages are connected to each other and to small urban centers by a network of private rural transportation.

#### (c) Labor Villages and Camps

These are agricultural labor villages and camps established in the irrigated agriculture schemes. They are, therefore, an outcome of the agricultural development activity in the fertile clay plains of central Sudan. The great majority of these villages are inhabited by a complex of tribes from Western Sudan and *fellata*. They provide most of the labor force needed for work on farms. Also, they sharecrop and rent agricultural land while few of them operate small farms.

Inhabitants of these villages have no direct access to basic services such as pure water, schools, health facilities and electricity. In recent years these villages played a major role in absorbing some of the environmentally and war displaced persons from Kordofan and Darfur.

#### (d) Hafir and Borehole Villages

These are villages established around hafirs and boreholes in the mechanized rainfed agriculture schemes. Excavation of hafirs and boreholes in central Sudan permitted crop production and establishment of new villages. Inhabitants of these villages practise rainfed cultivation of sesame and sorghum and they raise cattle and sheep. People and animals in these settlements are both vulnerable to variations in the amount of rainfall. These settlements are, therefore, not very stable in years of low rainfall.

### (e) Small Urban Towns

Associated with the transformation of rural economies from nomadism to commercial agricultural production is the emergence of small urban towns in central Sudan. These are usually located in the middle of groups of village settlements. Some of these towns were village centers of trade where roads from different directions converge. Some of them were places for religious gathering where people meet to express loyalty, admiration and obedience to a religious leader. Others came into existence for the first time as a result of agricultural development and establishment of administrative headquarters and offices. However, all of them played a major role in social change, distribution of basic goods and forest products (wood and charcoal) and penetration of urban values. Also, they have played a major role in accommodating refugees and victims of drought, famine and war.

## 3. The Role of the Government

Early in this century the British government was concerned with the future of cotton textile industry. Production of raw cotton in the empire was declining; particularly in Egypt and India. Also, the industry was facing competition from Japan, the United States and China. Concurrently, there was a desire to enable the colonial government of Sudan to finance its administration and not to become a burden on the British government. On the other hand, research indicated that the fertile clay plains of central Sudan are suitable for growing cotton. These circumstances and several other ones not mentioned here brought about the establishment of irrigated agricultural schemes in the Sudan.

The first irrigated agriculture project was Al-Gezira scheme which was established in 1925. It is the largest project in the Sudan covering an area of about 2 million *feddans* (1 feddan = 1.038 acres). Following Al-Gezira model several irrigated agriculture projects were established in Khasm Al-Girba (1964), Al-Suki (1972) and Al-Rahad (1977).

Before the establishment of irrigated agriculture schemes, land in central Sudan was communal (MacMichael, 1954; Gaitskell, 1959). The government put all land under its effective control, then, having divided it into manageable units of uniform size to conform with the needs of systematic irrigation, reallocated it to tenant farmers who pay land and water charges to the government. Later, this arrangement proved to be a major factor behind the success of the irrigated agriculture schemes (Barnett, 1977).

Tenant farmers have no right over land other than using it. A tenant farmer cannot sell or mortgage land. Also, under no condition should a farm be divided to units smaller than the standard size set for irrigation management. Moreover, the government have the right to take the farm whenever a tenant farmer proves unable to cultivate it according to a fixed cropping schedule.

These arrangements and regulations neglected population pressure on land which came about as a result of labor demand dynamics. Firstly, labor migration to the schemes has been continuing for several decades; labor migration to the Al-Gezira scheme alone is estimated at about half a million persons annually. Secondly, fertility

in these schemes has been found higher than in any other part of the country. These two demographic dynamics played a major role in land fragmentation and landlessness.

Population pressure and inheritance have led to the halving of standard farms. This is particularly evident in Al-Gezira scheme where about 80 per cent of the farmers are operating half-size farms. In some instances two families or more operate one farm. Occasionally it is possible to find a household where more than one member possesses half a tenancy.

Moreover, in the process of household formation new generations are increasingly becoming landless. Another factor contributing to the process of landlessness is the movement of families and displaced households for permanent residence in the irrigated schemes. Population pressure is reflected in the expansion of residential areas in villages and small urban centers at the expense of agricultural land. In recent years this problem became an issue of major concern to the scheme authorities as more people are building permanent houses on agricultural land adjacent to villages.

Another aspect of agricultural development is the introduction of mechanized rainfed agriculture in Central Sudan. The first mechanized rainfed farms started in 1945 in the Gedarif area primarily for the purpose of producing food for army units stationed in East Africa (ILO, 1976). Mechanized farming developed rapidly after 1953 when the government decided to allot land to private entrepreneurs. Since then the technique has been expanded to eastern Sudan, southern Blue Nile and southern Kordofan. Mechanized rainfed land is now estimated to extend to about 8 million feddans.

Mechanized rainfed farming is characterized by large size of farms and use of tractors for land cleaning, ploughing and planting. Farmers in their own private farms grow sorghum, short stable cotton, sesame and sunflower. mechanized farming is totally dependent on the amount of rainfall, and therefore it is vulnerable to shortage and climatic risks. For example, its share in total food production had fallen from 41 per cent in season 1981/82, which was a good rain season, to 15 per cent in season 1984/85, which was a season of low rainfall and drought. By contrast, large-scale irrigated agriculture contributed 61.7 per cent of local food production in 1984.

#### **4. Marginalization of Nomads**

Before establishment of the irrigated and rainfed agriculture schemes the central clay plains of the Sudan were inhabited by nomadic tribes. These tribes adapt to the environment by adopting a system of life based on social structure, communal use of resources and seasonal patterns of migration. With expansion of irrigated and mechanized rainfed agriculture in the fertile clay plains of central Sudan, nomadism as a system of life became very limited. Expansion of agriculture has set physical limitations to the migration patterns of nomadic tribes. In particular, the long distance migration has been considerably shortened. As nomads are not allowed to graze their animals in cash crop production areas, pasture became very limited too.

Nomadic tribes face immense difficulties in watering their animals. They have lost their traditional watering points on river banks to expanding private pump schemes. Also, the *hafirs* which were established to provide water to nomads, have gradually become

surrounded by permanent village settlements in the cultivated rainfed land, with settlers denying the nomads the right of using them. Availability of water and land for pasture have been further limited by climatic variations and changes in the amount of rainfall. Nomads were environmentally squeezed by the severe drought of 1984. They lost most of their animal wealth, which is their major form of investment.

Historically, the supply of surface water and rainfall permitted crop production in the Sudan to win the competition for land use against livestock and forestry. Consequently, nomads were pushed into marginal land that have a limited capacity to support growing livestock and human beings. For example, a large number of the White Nile Arab nomads and their animals were displaced to dry dune areas west of the river as a result of the construction of Jabal Al Awlia dam and reservoir on the White Nile and expansion of commercial irrigated agriculture (Kates and Haarmann 1992).

Also, the Blue Nile nomads who lived on the eastern side of the Blue Nile river and who were used to crossing the river during the dry season for pasture and water in Al-Gezira are no longer practising their annual migration cycle between the clay plains in Al-Gezira in the winter dry season and the sandy upper land in the summer, which was balancing the use of resources. They cannot move to Al-Gezira to compensate for the dry season decrease in surface water and pasture. Moreover, they have been pushed further to the east as a result of the establishment of Al-Rahad scheme in 1979 in the eastern side of the river. Therefore, nomads and livestock became concentrated on marginal land resulting in overgrazing and immense pressures on the environment. Competition over land use is more severe in Western Sudan. Camel herders, mainly of Arab origin, usually migrate north towards the Sahara desert in the rainy season, and south in search of both water and pasture during the dry season. Cattle owners (*Baggara*) and the traditional farmers are located immediately to the south of this zone. Because of low rainfall and expanding traditional farming, pasture land is getting substantially reduced. The movement of camel owners southward brought them into more frequent contact with the traditional cultivators and cattle owners. Competition over land use between these population groups in Western Sudan resulted in tribal warfare and social and political unrest.

## **5 Population Settlements and Biomass Fuels**

Urban, rural and nomadic settlements depend substantially on fuelwood, charcoal, agricultural residues and animal waste for cooking, housing, and manure for agricultural production. Therefore, various population settlements and sectors of the economy compete for available biomass resources. Analyses in this section are based entirely on published data obtained from the Ministry of Agriculture, Animal Wealth and Natural Resources and the National Energy Administration in the Central State.

## 5.1 Biomass Fuel Resources

### (a) Wood Resources

Wood resources and wood supplies are not identical terms as they may seem to be. Wood resources refer to the standing stock of wood. Wood supplies, on the other hand, refer to the annual cut of wood. Sustainable wood supplies are those which can be cut without depleting the initial stock of wood. If the annual cut of wood exceeds annual growth of standing stock then the resource base is being depleted. The standing stock of forests, their renewal process, amount and rate of growth of consumption all interact to determine the rate of wood resources depletion.

Wood resources in central Sudan, sustainable cut and the amount of licensed production are shown in Table 3. The Ministry of Agriculture estimated wood resources of central Sudan at about 123 million cubic meters in an area of 3.6 million hectares of land. These figures give an average wood density of 34 m<sup>3</sup>/hectare. Most of the wood resources are located in the Blue Nile with an average density of 36 m<sup>3</sup>/hectare. Wood density in Al-Gezira is 38 m<sup>3</sup>/hectare, suggesting more intensive planting. The White Nile has a significantly lower resource base than the other two parts.

**Table 3. Wood Resources in Central Sudan**

	area (000)	Volume 000m <sup>3</sup>	Density m <sup>3</sup> /hectare	Sustainable cut 000m <sup>3</sup>	Licensed cut 000m <sup>3</sup>
Gezira	59	2226	37.7	122	597
Blue Nile	3376	120773	35.8	4227	1670
White Nile	238	234	0.9	8	1121
Total	3673	123233	33.5	4357	3388

Source: Energy Assessment Report. National Energy Administration, 1987.

### (b) Agricultural Residues and Animal Wastes

Unlike wood, agricultural residues are reproduced in a very short period (every 3 to 4 months period). The supply of agricultural residues depends on the area cultivated and crops produced. Cotton, wheat, dura and groundnuts are the four major sources of agricultural residues in central Sudan. Most of the cotton stalks, wheat stalks and groundnut shells are produced in the irrigated agriculture schemes in Al-Gezira (Table 4). Dura stalks are primarily produced in the mechanized rainfed farming in the Blue Nile. Traditional agricultural areas located in the White Nile produce few agricultural residues.

The supply of animal waste, on the other hand, depends on the size and types of animal herds and presumably how much they eat. Most of the animal waste is produced by animals in the White Nile where nomadism is widespread. Some cattle and sheep are raised by the sedentary village cultivators in Al-Gezira and the Blue Nile.

## 5.2 Biomass Fuel Consumption

### (a) Wood Consumption

Households in central Sudan consume annually an average of 593 thousand metric tons of wood (Table 5). Families of Al-Gezira account for only 5.6 per cent of wood consumption as compared to the Blue Nile (49.9 per cent) and the White Nile (44.4 per cent). The overall average per capita wood consumption is 260 kilos per year. Variations in per capita wood consumption by mode of living are striking (Table 6).

**Table 4. Supplies of Agricultural Residues and Animal Waste in Metric Tons (mt)**

	Agricultural Residues	Animal Waste
1. Gezira	2802573	1135422
Cotton	1463858	
Wheat	305762	
Dura	897008	
Groundnut	135945	
2. Blue Nile	5156797	1333056
Cotton	62797	
Dura	5094000	
3. White Nile	2193658	2336751
Cotton	75388	
Wheat	30270	
Dura	2079000	
Groundnut	9000	
<b>Total</b>	<b>10153028</b>	<b>4805229</b>

Source: Energy Assessment Report, National Energy Administration, 1989.

**Table 5. Biomass Fuels Consumption by Households in Metric Tons (mt).**

	Gezira	Blue Nile	White Nile	Total
Wood	33335	296053	263551	592939
%	5.6	49.9	44.4	100
Charcoal	234842	128838	117736	481415
%	48.8	26.8	24.4	100
Agricultural Residues	721194	104977	43565	869736
%	82.9	12.0	5.0	100
Animal waste	142027	10065	4924	157016
%	90.4	6.4	3.1	100

Source: Energy Assessment Report, National Energy Administration, 1989.

On a per capita basis, nomadic tribes are the major consumers of wood resources for fuel, fencing, construction of tents etc. Average yearly per capita wood consumption is highest among the nomadic tribes of the White Nile (413 kilos). By contrast, wood consumption among the urban inhabitants is low, ranging between 50 kilos for urban households in Al-Gezira and 127 kilos for urban households in the Blue Nile.

#### (b) Charcoal Consumption

Of the 481 thousand tons of annual charcoal consumption in central Sudan, 49 per cent is consumed in Al-Gezira, 27 per cent in the Blue Nile and 24 per cent in the White Nile. Settled rural households consume 73 per cent of the charcoal, urban households 23 per cent and nomads 4 per cent. The highest per capita charcoal consumption is 141 kilos for the White Nile urban households and the lowest is 37 kilos for nomads in the same province. Charcoal consumption is higher among urban than rural residents; particularly urban residents of the Blue Nile and the White Nile. This result is expected particularly for the wood-rich charcoal production area of the Blue Nile. On the other hand, similarity of charcoal consumption between the urban and rural Al-Gezira is not unexpected. Rural settlements in Al-Gezira are highly monetized because of cash crop production in the irrigated schemes. By contrast, rural households in the Blue Nile and the White Nile practise subsistence agriculture, and therefore tend to rely less on commercial fuels, preferring to gather wood instead.

#### (c) Wood and Charcoal Consumption By Other Sectors

Households are not the only consumers of wood and charcoal, there are two other sectors competing, namely industries and commercial enterprises (Table 7). Industries consume an average of 202 thousand tons of wood most of it by bakeries (51 per cent) and brick kilns (48 per cent). Commercial establishments consume an average of 22.4 thousand tons of charcoal and 2.3 thousand tons of wood a year; almost entirely (99 per cent) by the urban-based commercial enterprises. Pastry shops and restaurants are major consumers of wood accounting for 41 per cent and 35 per cent of total wood consumption respectively.

**Table 6. Per Capita Consumption of Biomass Fuels by Type and Mode of Living (Kilos per year).**

	Wood	Charcoal	Agricultural residues	Animal waste
<b>Urban</b>				
Gezira	50	110	162	23
Blue Nile	127	125	44	4
White Nile	122	141	9	10
<b>Rural</b>				
Gezira	3	108	172	76
Blue Nile	292	114	112	11
White Nile	287	111	62	4
<b>Nomadic</b>				
Gezira	279	99	142	0
Blue Nile	311	77	31	0
White Nile	413	37	30	0

Source: Energy Assessment Report, National Energy Administration, 1989.

**Table 7. Wood and Charcoal Consumption by Sectors of the Economy.**

	Wood	Charcoal
Households	592939	481415
Industries	202036	
Commercial Enterprises	2395	22476
<b>Total</b>	<b>797370</b>	<b>503891</b>

Industries: bakeries, brick making, workshops and small industries

Commercial Enterprises: Inns, hotels, clubs, restaurants, tea houses, pastry shops etc.

Source: Energy Assessment Report, National Energy Administration, 1989.

#### (d) Consumption of Agricultural Residues and Animal Waste

Agricultural residues and animal waste are a major source of cooking fuel in central Sudan. These two sources together make 48.8 per cent of total biomass fuel consumption. Agricultural residues are an important source of energy for rural, urban and nomadic households of Al-Gezira (Table 6). While less in other areas, the use of agricultural residues, particularly dura stalks, is quite noticeable among the rural households of the Blue Nile.

The consumption of agricultural residues and animal waste is far below the average annual supplies. Only 8.5 per cent of the former and 3.3 per cent of the latter are consumed by households. These results indicate great potential for expanded use of these biomass fuels as substitutes for wood and charcoal. In fact, substitution away from wood and charcoal fuels towards agricultural residues and animal waste has occurred in Al-Gezira, where they are free and within easy access to the rural and urban inhabitants. The nomads of Al-Gezira, by contrast, don't have such easy access

to residues as they are required by law to keep their animals away from the crop production area. Nomads, therefore, operate in the periphery of the irrigated schemes where some wood resources are available free.

## 6. Concluding Remarks

Water and land are the most important natural resources in determining population distribution and settlement patterns. In areas where permanent water supplies cannot be determined, people may occupy the land for a short period of 2 to 3 months to graze their animals and cultivate few crops. When the dry season comes they migrate to other sites where water is available. Permanent population settlements such as villages and small urban centers are located on river banks, near irrigation canals and around *hafirs* and deep boreholes.

Rural development policies in Sudan are always in favor of sedentarization because it is believed to provide a better utilization of human resources for development and modernization. Sedentary life allows for easy integration of people into one nationhood, sedentarized tribes being easy to control through security and administrative services. On the other hand nomadism is considered incompatible with development and modernization because of difficulties in spreading education, services, political control and justice, as well as nomads having strong tribal loyalties and being considered wasteful of resources

Various population settlement groups and sectors of the economy compete for the available biomass resources. Nomadic tribes are the major consumers of wood resources. On the other hand, agricultural residues are produced in quantities sufficient to satisfy all biomass energy needs. In fact, there is great potential for expanded use of agricultural waste as a substitute for wood and charcoal.

Analyses of biomass fuel consumption indicate considerable use of wood and charcoal in central Sudan. The average annual licensing of wood cut is approximately 3.4 million m<sup>3</sup> which is equivalent to 578,332 tons of wood fuel plus 183,718 tons of charcoal production. Comparing these figures with the overall average annual consumption of wood and charcoal by all sectors of the economy (households, industries and commercial enterprises 797370 metric tons of wood fuel and 503891 metric tons of charcoal) imply substantial unofficial cut of wood. In fact, consumption of wood and charcoal exceeds licensed supplies.

Also, the overall wood consumption exceeds the amount of sustainable cut. Assuming a cut rate of 0.035 for the Blue Nile and the White Nile and a rate of 0.055 for Al-Gezira, we can derive the annual amount of sustainable cut (Table 3). This refers to the supplies of wood which would leave the standing stock unchanged. The overall sustainable cut is estimated to be 4.3 million m<sup>3</sup> most of it in the Blue Nile. By contrast, the annual official cut licensed by the authorities is 3.4 million m<sup>3</sup>. The licensing of wood cut in Al-Gezira and the White Nile exceeds sustainable cut by 475 thousand and 1113 thousand metric tons respectively (Table 3). Official licensing, therefore, encourages deforestation. Considering unofficial licensing of wood cut and the considerable consumption of wood by households, industries and commercial enterprises, the extent of deforestation would appear far greater than implied by official licensing alone.

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## CHAPTER 21

# DOMESTIC WATER SUPPLY TRENDS IN TANZANIA: RURAL AND URBAN CONTRASTS

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### 1. Introduction

This exploratory analysis looks at the relationship between regional population growth and trends in domestic water supply in Tanzania, in the most recent intercensal interval (1978 –88) for which data are available. The census data indicate a substantial decline in the proportion of households obtaining drinking water from piped supplies, as well as a decline in proportions obtaining drinking water from any source internal to the dwelling or compound. By the simple means of comparing the growth in the number of households in each region with the changes in the regional number of households obtaining drinking water from different sources, we try to establish whether the government's provision of piped water, and individual or community attempts at self-provisioning from the most convenient, internal sources, are keeping pace with population growth at a regional level. Analysis of the correlation between growth rates shows that in urban areas, rapid population growth itself may be a contributory cause to the decline in the proportion of households obtaining drinking water from the more desirable sources, but that in rural areas this is not the case.

### 2. Background

Without water to drink, humans cannot survive longer than a few days, so all permanent households must have a water supply. In the 1980s campaigns to improve people's knowledge about the importance of the quality of this water supply for general health have attempted to reach even the remotest rural dwellers, as part of the United Nations Water and Sanitation Decade. Tanzania has participated in this action, with educational programmes promoting the protection of traditional water supplies, and the use of "the three pot method" for domestic storage. If such programmes have succeeded, we would expect to see an improvement in the distribution of drinking water sources between the 1978 and 1988 censuses, with a shift away from reliance on the most easily contaminated sources such as ponds and surface flows, to safer sources such as wells and piped water filtered and treated with modern chemicals by the water utility.

Since the formation of the Water Development Department in 1946, the Tanzanian government has embarked on a very ambitious programme of providing piped water, in both rural and urban areas (Mambali, 1992). Under the first schemes, local authorities

were required to contribute to the costs of water development projects, but their proportionate contributions were decreased in successive policy changes aimed at redressing the balance between the richer urban areas and the rural hinterland, until by 1965 the central government was financing all new water investments, and in the 1970s even began to pay for operating and maintenance costs, and providing rural water services free of charge (Kauzeni, Mujwahuzi & Kiwasila, 1990). The Twenty Year Rural Water Supply Programme (1971–90), was formulated on the premise that access to clean water was a basic human right, and its aim was to extend piped water supplies to within 400 m of every household by 1991 (Mambali, 1992).

Under this programme, Water Master Plans were commissioned in 15 of the 20 regions of the Tanzanian mainland, using a series of donor agencies to finance reviews of the demand levels and supply constraints. These reviews collected data on population, land use, geological and hydrological data at the level of individual villages (Agrar-und Hydrotechnik, 1976; DHV, 1971; CBA, 1979; Finnwater, 1977; Carl Bro, 1982; SMEC, 1978; Norconsult, 1982; Brokonsult, 1977). The studies produced masses of high quality data, at an extremely fine geographical breakdown – much of it so detailed that it has never been summarized at the district or regional level. The Regional Water Master Plans have formed the basis of donor financed schemes for developing improved water supplies in many regions.

In 1991, the first comprehensive water sector policy was officially launched by the government, and this embodies the principle of payment for improved water supplies by all end-users (Mambali, 1992). In fact, those urban residents who benefited from a piped supply into their own home had always paid for the connections to the municipal water supply on a flat rate basis, but people who used standpipes and hand pumps connected to boreholes received their supplies free. Since the introduction of the new policy, water meters have begun to be introduced for households connected to municipal piped water supplies, substantial increases in the flat charges have been made, and kiosks have been constructed round stand pipes in urban areas, to levy charges for the water obtained (Kiwasila, 1994). In rural areas, villages are to be made financially responsible for the maintenance of pumps installed in their areas. Village water committees have been traditionally responsible for the maintenance of hygienic conditions around communal wells and this will continue to be encouraged. The reforms enacted by the new policy would not have affected the changes in water use observed between the 1978 and 1988 censuses.

As a result of government policy and investment, supplemented by foreign aid, the proportion of urban households with a piped drinking water supply, grew from 70 per cent at the time of the 1967 census, to 88 per cent in 1978, in spite of a growth in the total number of urban households of 188 per cent in the same decade (we cannot use census data to estimate changes in rural areas, since water supply data were only gathered in urban areas in 1967.) The 1978 to 88 decade however, saw a sharp reversal to this favourable trend, as is shown in Table 1.

In both urban and rural areas there has been a decline in the proportion of households obtaining drinking water from a piped supply. This is true for all households using piped water, and for those with inside and outside piped supplies considered separately. This fall was compensated by a rise in the proportion using wells, especially wells outside the dwelling or compound. However, in urban areas this percentage decline in piped water merely reflects the fact that the total number of households has grown faster

than the number with a piped supply, while in rural areas there has been an absolute decline in the number of households using piped drinking water – from 829,000 in 1978 to 644,000 in 1988. The proportion of households benefiting from any kind of drinking water supply inside the dwelling or compound has also declined – from 41 to 35 percent in rural areas, and from 38 to 34 per cent in urban areas. Again, in the case of rural areas this represents an absolute decline, though not a very large one – just over 3,000 fewer households had an internal water supply in 1988 than in 1978.

**Table 1. Percentage of Rural and Urban Households by Water Supply, 1968–1988**

	Year	Total households	Internal			External			household size
			piped	well	other	piped	well	other	
Rural Areas	1978	2994456	11	18.9	10.1	16.1	27.5	15.	4.9
	1988	3480233		22.3	6.	12.7	38.2	14.	5.4
Urban Areas	1968	194591	20	n.a.	n.a.	48.9	n.a.	n.a.	3.5
	1978	560337	34	2.	1.	54.1	5.7	2	4.2
	1988	939405	27	5.	0.	52.1	11.5	2	4.5

The basic data on changes in drinking water source in each mainland region and for the whole of Zanzibar are given in the appendix (Table A1). Most regions experienced similar patterns of change to those seen at the national level, with only five regions (Rukwa, Kigoma, Mbeya, Mtwara and Lindi) showing increases in the proportion of households using piped water in rural areas, and three (Dodoma, Iringa and Singida) with increased proportions of piped water use in urban areas. In most of these cases, the increased use of piped water is due to a large increase in the use of external stand pipes rather than internally supplied piped water.

Various theoretical traditions could be invoked to explain relationships between demographic growth and use of resources such as drinking water. The neo-Malthusian school of thought, most notably represented in the field of water resources by Falkenmark (1994), would predict a worsening of the supply situation in semi-arid areas in the face of rapid population growth. Indeed, Falkenmark (1989) has identified Tanzania as one of several African countries which will move from a situation of intermittent water crises to one of chronic water shortage in the 1990s. Falkenmark is chiefly concerned with agricultural rather than domestic use of water, and indeed, domestic use in Africa is estimated to account for only 7 per cent of the total amount available in the environment. But one could speculate that increasing abstraction of water for agricultural and industrial uses to satisfy the needs of a growing population, would lower water tables and reservoir levels, and thereby have an impact on domestic availability also. Added to this, we might expect that the provision of adequate infrastructure for catchment, purification and delivery would be more difficult in the face of rapid population growth.

On the other hand, history offers many examples of technological advances in the provision of water supplies being spurred by population growth, particularly by the concentration of population in urban areas, as it is cheaper to provide piped supplies in densely settled areas. Indeed, the very contrast between the relatively favourable water supply situation in the densely populated urban areas of Tanzania with the position in the sparsely populated rural areas would tend to back this interpretation. Furthermore, the proportionate changes in piped supplies, and in internal supplies of all kinds, have been worse in the rural areas, which grew by 16 per cent in the intercensal decade, compared with changes in urban areas which grew by 68 per cent in the same period. So although the better types of water supply may not be keeping pace with population growth – for whatever reason – it might be argued that population growth is not a cause of their relative decline.

The more advanced development of water supplies in urban areas may have been originally spurred by factors other than population growth – e.g. the location of colonial administrative authorities and the demands of a wealthy urban elite. In rural areas the presence of foreigners – e.g. plantation owners, missionaries or aid workers – may also have influenced the relative pace of development of modern water supply technology. The natural location of a reliable, potable and palatable water supply has long been thought to be an important factor in determining settlement patterns in Tanzania (Allan, 1965; Gillman, 1945). Once any kind of improvement to local water supplies has been made, population may be attracted to the area. It is also possible that the secular relationship between population density and convenience of water supply in any given area is non-linear – that is, population growth could act first to encourage the development of convenient water supplies, but after some critical density is reached further growth may force people to use less desirable options.

The large declines observed in use of piped water in the last intercensal decade, are attributed by local experts to mechanical failures, shortages of expertise in servicing imported machinery and the lack of foreign exchange to purchase spare parts (Mujwahuzi, 1993). If this is the major explanation for all the deterioration in the water supply situation, we would not necessarily expect to see any correlation between supply changes and population growth. The worst affected regions would presumably be the ones most reliant on foreign technology for domestic water supplies – in all probability, the very regions which achieved the largest coverage of piped water supply in the decade of rapid expansion in the 70s. However, if the quality of a regional water supply was primarily determined by political connections between regional and national authorities, we might expect to see the most favourable changes in areas with good supplies over periods of time in which the power relationships remained stable.

This study examines the changes in water supply at the regional level between 1978 and 1988, looking at urban-rural differentials, and tries to establish whether the apparent deterioration in household water supplies is associated with rapid population growth and/or previous development of water sources. Regional indicators of rainfall, agricultural potential and socio-economic status are also examined in relation to water supply distribution and changes.

### 3. Data Sources and Quality

The data used in this study come mainly from the 1978 and 1988 censuses of Tanzania, though some use has been made of other secondary sources, such as the spatial analysis of rainfall and rural economic activity data by Berry (1973). Even with such a modest data collection there are problems of compatibility and continuity. Rainfall does not respect administrative boundaries, and may vary widely across a region – the mean annual rainfall figures obtained by interpolation between isohyets should therefore be regarded as crude approximations. There are also some differences in detail between census tables published in the two years: in 1988, individuals and households were both classified by source of water, but for 1978 only a household classification is available, and there are minor differences in the provision of urban/rural breakdowns for some socio-economic variables. The census questions on water use were identical in both censuses, as were the formal instructions to enumerators embodied in the training materials.

The regional breakdown presented in this analysis generally follows the administrative categories used by the government statistical bureau, except that Zanzibar is treated as one analytical unit, whereas for administrative purposes it is divided into 5 regions. The administrative regions of Zanzibar are actually about one-fifth of the size of the smallest of the 20 mainland regions. The aggregation used here ensures that the analytical units are of a broadly similar size – between 100 and 300 thousand households when rural and urban areas are taken together.

The overall quality of the demographic data collected in the 1988 census has been ascertained as quite good (Zaba *et al.*, 1991), by means of the usual consistency checks, and similar quality checks on the 1978 census data were performed by Rafiq *et al.*, (1983). In Tanzanian censuses, the detailed demographic and household information is obtained from a sample of households (about 14 per cent in 1988), other households just providing a return of members by sex and age. All the estimates presented here are therefore subject to sampling error. In 1978, it was believed that large estate households were oversampled in the rural areas of Arusha, Kilimanjaro, Tanga, Morogoro, Coast and Iringa. In so far as such households may have had better water supplies than others in rural areas, there is a possibility that the recorded 1978 supply situation in these areas may have been favourably biased compared to 1988.

The data on water supply are obtained from the census question which asks about the main source of drinkable water for the household. This is categorized as piped, well and other, each being further divided into inside or outside the dwelling or compound. In urban areas, it is common to find more than one household in a single dwelling, whereas in rural areas, a single household may occupy several huts grouped together in a compound.

It is not possible to obtain measures of water quality or of quantity of water used, nor is it possible to take account of changes in supply between wet and dry seasons. However, the two censuses were both conducted in August, so the effect of seasonality of source use should not bias the results of one census relative to the other. The simple division into inside and outside the dwelling or compound does not permit any comparison of how far the external sources lie from the usual household residence, and this may vary widely, particularly between rural and urban areas.

The data on sources used for drinking water may not reflect the true availability of a particular source in a given region, since choice of source may be dictated by other factors – for example, piped water may be available from a neighbouring house in an urban area, but a hand pump at a communal well may be preferred, for reasons of taste, cost, reliability of flow or opportunity for socialization. Where water for washing is obtained from a different source to water for drinking, the data presented here would not represent the volumes actually used for domestic purposes from each source. Finally, since piped water is used more abundantly and is generally associated with a high degree of wastage due to leakages, the proportion of households using piped sources is far lower than the proportion of environmentally available water captured by the utilities for feeding into the piped system as a fraction of the total amount of water captured for domestic consumption.

Some explanation of the terms used to describe water supply in Tanzania may be useful, particularly to highlight urban and rural contrasts. A household described as having a "piped water supply into the house or compound" may range from a single family house with modern plumbing throughout, including flush toilets, to a communal dwelling, housing several unrelated households, sharing a single outside tap in the yard. Water companies generally charge for a piped supply on a flat rate basis, though water meters have recently been introduced into some urban areas. Individuals living in dwellings with piped water often supply water to others – this is particularly common in urban areas. This may be done free of charge, or for an agreed monthly fee, or even on a "per bucket" basis. Households reported as obtaining water from a piped source outside the house or compound could therefore be benefiting from water piped into a neighbouring dwelling, or they could be using free communal standpipes or municipal water kiosks at which piped water is sold by the bucket (Kiwasila, 1994).

The term "well" is used to cover simple, shallow wells, improved wells with stone or concrete ring linings and lids, deep drilled wells, and even boreholes with hand pumps for raising water. In rural areas, trading in drinking water from wells is uncommon, as most households would have access to some communal source, and in any case, it would be considered unethical to deny a neighbour access to drinking water, although charges can be made for watering cattle (Drangert, 1993). But in urban areas, water from wells in private enclosures may be sold, just as with piped water. "Other" sources vary widely between rural and urban areas, and different regions of the country. "Other internal" would generally describe rainwater collection from a metal roof to a large storage tank, and this would occur in both rural and urban areas. In rural areas, "other external" could refer to water from springs, water-holes, rivers and river-beds, lakes, ponds, and dams (White *et al.*, 1972). Households in urban areas would be less likely to use such sources, as they are less accessible and because open water in urban areas tends to be too polluted for human consumption. However, water supplied by mobile vendors in urban areas would also be described as "other external", whatever its original source.

There are large differences between regions in the total amount of rainfall, and smaller differences in its seasonal pattern. The heaviest rainfall occurs in a narrow coastal strip, on the western shores of Lake Victoria, and over mountainous parts of the country: Kilimanjaro and Meru in the north-west, the Central ranges running north-east to south-west from Morogoro through Iringa to Mbeya, and the highland in the west between lakes Nyasa and Tangyanika, which forms the eastern wall of the rift valley.

The northern parts of the country tend to have two distinct rainy seasons, with a higher peak in March–April and a lower one in September–October, whereas in the south there is only one maximum, in October–November. June and July are dry months throughout the country. There is quite marked variability in rainfall even within regions, some of which stretch across important physical features such as mountain ranges, lakes and watersheds – in Arusha region, for example, the area around the town of Arusha, at the foot of mount Meru, has over 1000mm of rain per annum, but much of the rest of the region has under 600mm. The rainfall data shown in the appendix, Table A2, have been derived from maps and tables presented by Berry (1971) by interpolating across grid squares.

Population density in rural areas is not available directly from published sources, since the land areas of urban and rural census tracts are not given. Rural densities have been obtained indirectly, by estimating the urban area on the assumption that the general density of urban settlement is 500 persons per km<sup>2</sup>, rising to 1,000 in the more heavily urbanized regions in Arusha, Kilimanjaro, Tanga, Kigoma and Mwanza, and reaching 2,500 in Dar-es-Salaam and Zanzibar. In most regions, the proportion of urban population is so small, that it would make less than 1 per cent difference to the resulting rural density if it were calculated on the basis of the entire area of the region. Zanzibar and Dar-es-Salaam have the highest rural densities, both over 150 persons per km<sup>2</sup>, Rukwa and Lindi are the most sparsely settled, with under 10 persons per km<sup>2</sup>.

Dar-es-Salaam and Zanzibar also have the highest proportions of their populations living in urban areas: 91 per cent and 33 per cent respectively, in sharp contrast to all other regions which have below 15 per cent in urban areas. The least urbanized regions are Shinyanga and Kagera, with under 5 per cent. Rural densities and proportions living in urban areas in 1978 at the start of the period for which change is analyzed, are shown in the appendix, Table A2.

There is a considerable difference in the rural economies both between and within regions. Berry (1971) produced a profile of rural economic performance at district level, calculating per-capita income for rural inhabitants. A ranking of regions (shown in appendix Table A2) has been constructed on the basis of the district profiles, which shows that the wealthiest regions are Dar-es-Salaam and Morogoro in the centre of the country, and the North-Eastern regions of Kilimanjaro, Tanga and Arusha. The poorest regions in 1971 were Rukwa, Singida, Mara and Dodoma.

The final socio-economic variable used to differentiate the development level of each region at the start of the intercensal period is female literacy. For the country as a whole, this was 35 per cent in 1978, but it ranged from over 65 per cent in Kilimanjaro, to below 20 per cent in Shinyanga.

#### **4. Methodology**

One simple way of investigating the influence of population growth on water supply, is to invent a supply score for each region, based on the proportion of households obtaining drinking water from different sources according to the perceived desirability of the source, and then to analyze changes in the score with respect to population

growth. The water sources described above have been ranked by perceived desirability, from the point of convenience and hygiene, as shown in Table 2.

**Table 2. Ranking of Drinking Water Supplies Used in Analysis**

Rank	Source	Assumptions
1	piped internal	most convenient, minimal domestic storage required, filtered and possibly chemically treated
2	well internal	convenient, household can exercise control over sanitary maintenance of well
3	other internal	mainly roof collection: convenient, but long domestic storage required, subject to interruption in dry season
4	piped external	filtered and possibly chemically treated* water, own vessel used for collection
5	well external	little control over well surroundings, may have to use communal vessel for drawing water
6	other external	mixed unprotected sources in rural areas, mobile vendors in urban areas

\* not all piped water supplies in Tanzania are chemically treated on a regular basis

It is assumed that in regions where highly ranked sources are available, and affordable or attainable by households hitherto using sources with a low ranking, there would be a gradual improvement in the frequency distribution of households by water source. Since the population is growing in both rural and urban areas of all regions (except for the rural area of the Coast region, where the number of households has remained almost constant), such an improvement would be seen even if no households actually changed to a different supply, but simply if newly formed households had a more favourable distribution of supply than existing households, or if households which dissolved in the intercensal period had a less favourable distribution of supply than the average.

If there is a worsening of the proportional distribution of households by water source over time, this could indicate that newly formed households are obtaining drinking water from inferior sources to those used by existing households, or that existing households are abandoning the higher ranked sources, or that households with highly ranked sources are more prone to dissolution than households with lower ranked sources. Since a dwelling with an internal water supply of any kind represents a considerable investment of labour and/or household income, it is unlikely that such dwellings would remain vacant for any length of time. An absolute fall in the number of households with highly ranked sources, in the face of rapid population growth, almost certainly represents a decline in the availability of water from these sources. This may be due to technical problems in the case of piped water, but a decline in the absolute number of households using sources ranked at least as high as wells, could indicate a deterioration in the quality or quantity of ground water available in settled areas.

Using the above ranking, we could score 5 for households with an internal piped drinking water supply, down to 0 for households using "other external" sources. Table 3

shows such scores for the urban and rural areas of each region in 1978, and the changes to the score observed between 1978 and 1988. It indicates that there has been a net movement towards inferior drinking water sources in most regions: in the rural areas 15 out of 21 regions show a negative change, and 14 regions show negative changes in urban areas. The average decline in the score is larger in rural than in urban areas, and since rural areas had lower scores in 1978, the gap between rural and urban areas widened by 1988.

**Table 3. Water Source Scores and Changes, 1978–1988**

Region	Rural areas		Urban areas	
	1978 score	change 78–88	1978 score	change 78–88
Dodoma	1.91	1.08	3.03	0.33
Arusha	2.50	-0.39	3.20	-0.50
Kilimanjaro	3.39	-1.33	3.67	-1.00
Tanga	2.41	-0.78	3.43	-0.31
Morogoro	2.55	-0.84	2.84	0.21
Coast	3.41	-1.65	3.36	-0.95
Dar-es-Salaam	2.22	-0.01	2.94	-0.09
Lindi	2.06	-0.05	2.70	-0.26
Mtwara	1.89	0.36	2.29	0.10
Ruvuma	2.13	-0.55	2.56	0.03
Iringa	2.82	-0.04	2.81	0.13
Mbeya	1.90	0.34	2.72	0.07
Singida	2.28	-0.67	2.32	0.25
Tabora	2.23	-0.29	3.03	-0.36
Rukwa	1.72	-0.48	2.57	-0.36
Kigoma	1.68	0.46	2.86	-0.05
Shinyanga	2.12	-0.11	3.38	-0.67
Kagera	1.69	0.08	2.30	-0.28
Mwanza	1.98	-0.20	2.82	-0.65
Mara	1.55	0.06	2.95	-0.69
Zanzibar	2.65	-0.37	3.77	-0.05
Tanzania	2.24	-0.22	2.98	-0.17

A scoring procedure produces summary statistics, but these are somewhat arbitrary, in that a numerical equivalence is created between different kinds of changes, and changes in opposite directions cancel out and remain undetected in the overall measure of change. A more satisfactory analysis would attempt to consider each type of supply separately, though it would be difficult to interpret an analysis of the growth rates of households obtaining water from a particular source in the middle of the ranking, where the majority of households are to be found –e.g. an increase in the proportion of households using outside pipes could be the result of a net movement into this category from any combination of other categories, and could not be used as an indicator of improvement or deterioration.

One way to overcome this interpretational difficulty, is to divide households into two groups according to the source ranking in Table 2 – e.g. the "superior" group could be those who obtained their water from all inside sources or from outside pipes, and the "inferior" group those who obtain their water from outside wells and other outside

sources. A comparison of the growth rates of households in the two groups with the overall growth rate would then show whether water provision was keeping pace with household growth at the level of the chosen boundary – in this case, between outside pipes and outside wells. If the superior group is growing slower than the total number of households, and the inferior group faster, we could describe this as a net worsening of the supply situation across this boundary. Net changes between supply categories within the superior group or within the inferior group would not affect our growth rate measures. This approach could also indicate whether the chosen ranking is sensible, in so far as one would expect to see systematic changes in the relationship between growth in the two supply groupings and overall household growth as the group boundary changed.

Mechanical failure of modern pumping schemes which were supposed to deliver piped water may be considered an irrelevancy in any attempt to measure population pressure on resources. Grouping the supplies in this way allows us to see how far down the desirability scale households which have had to abandon the use of piped water supplies have been forced to move. We can see whether the supply of the more highly desirable traditional water sources, such as wells, is able to keep up with the growing total number of households augmented by the number of households which are no longer able to obtain piped water.

Table 4 shows the intercensal growth rates of the superior group of households in each region, when the boundary is drawn successively lower down the source ranking. A negative growth rate indicates an absolute fall in the number of households in this category. To facilitate comparison, the figures for groups which grow faster than the overall household growth rate are preceded with a plus sign, whereas unsigned figures represent positive growth at a rate slower than household growth for the region.

Tables 4a and 4b highlight the contrasts between urban and rural areas noted in the introduction. In urban areas, growth in superior supply sources is positive in all but four cases: three regions experienced an absolute decline in internal piped water supplies, and only one in internal water supplies in general. In rural areas however, over two-thirds of regions have seen an absolute decline in internal piped water, half have experienced an absolute decline in all types of internal water supply, and in four out of the 21 regions there has even been an absolute decline in the cumulated number using sources at least as good as outside wells. In fact less than half of the regions have a growth rate faster than the total rural household growth rate for this last supply grouping. This means that there has been a fairly widespread increase in the proportion of rural households using the least desirable sources of drinking water: streams, river beds, ponds and lakes.

**Table 4. Growth in Households with Superior Water Supply and Overall Household Growth**

**a. Rural Areas**

Region	Supply at least as good as:					Overall Household Growth
	Inside Piped	Inside Well	Inside Other	Outside Piped	Outside Well	
Dodoma	+0.837	+1.585	+1.785	+0.528	+0.415	0.154
Arusha	-0.536	0.077	0.199	0.181	+0.393	0.383
Kilimanjaro	-0.546	-0.433	-0.536	-0.223	-0.131	0.105
Tanga	-0.748	-0.315	-0.184	-0.466	-0.080	0.042
Morogoro	-0.872	-0.352	-0.300	-0.326	-0.098	0.061
Coast	-0.893	-0.679	-0.664	-0.575	-0.020	-0.000
Dar-es-Salaam	+5.545	0.674	+0.717	0.513	0.684	0.691
Lindi	+0.191	0.050	0.058	+0.145	0.011	0.079
Mtwara	+1.353	+0.430	+0.308	+0.210	+0.250	0.086
Ruvuma	-0.046	0.012	-0.468	-0.304	0.183	0.222
Iringa	-0.192	0.170	0.178	0.192	+0.284	0.199
Mbeya	+1.167	+1.097	+0.379	+0.365	+0.345	0.234
Singida	-0.765	-0.387	-0.393	-0.367	0.127	0.135
Tabora	-0.783	-0.236	-0.220	-0.180	+0.253	0.098
Rukwa	-0.943	-0.328	-0.447	0.168	0.398	0.481
Kigoma	+0.732	+0.934	+0.464	+0.543	+0.581	0.248
Shinyanga	-0.653	0.167	-0.034	-0.025	+0.346	0.187
Kagera	-0.335	+1.618	+0.238	0.129	0.092	0.171
Mwanza	-0.891	-0.147	-0.113	-0.092	+0.174	0.098
Mara	-0.298	+0.454	+0.344	-0.060	+0.199	0.137
Zanzibar	-0.619	-0.123	-0.057	0.091	0.197	0.198
faster	6	6	7	5	10	
slower	0	6	3	6	7	
negative	15	9	11	10	4	

**b. Urban Areas**

Dodoma	+0.811	+0.908	+0.882	+0.687	+0.622	0.565
Arusha	0.174	0.356	0.411	1.080	1.078	1.100
Kilimanjaro	0.017	0.043	0.057	1.017	1.048	1.156
Tanga	0.150	0.211	0.217	0.417	0.430	0.457
Morogoro	+1.001	+1.386	+1.394	+0.928	+0.951	0.915
Coast	-0.132	0.523	0.526	0.989	1.278	1.498
Dar-es-Salaam	0.344	0.462	0.427	0.427	+0.492	0.491
Lindi	0.097	0.794	0.814	0.698	+0.941	0.937
Mtwara	+0.492	+0.864	+0.805	0.284	0.341	0.352
Ruvuma	+1.264	+1.231	1.115	1.028	+1.460	1.215
Iringa	+0.498	+0.483	0.340	+0.628	+0.499	0.451
Mbeya	1.755	+2.155	+2.047	1.753	+1.873	1.799
Singida	+0.242	+0.465	+0.358	+0.287	+0.216	0.161
Tabora	-0.017	0.021	-0.007	0.133	+0.294	0.290
Rukwa	0.628	0.508	0.440	0.482	0.856	0.902
Kigoma	+0.572	+0.783	+0.735	0.324	+0.559	0.557
Shinyanga	0.208	0.416	0.455	0.551	0.910	0.968
Kagera	0.157	0.716	0.501	0.761	+1.097	0.995
Mwanza	0.019	0.433	0.400	0.534	1.037	1.120
Mara	-0.182	0.012	0.030	0.630	0.898	0.920
Zanzibar	0.163	0.222	0.224	+0.243	+0.244	0.241
faster	7	8	6	5	12	
slower	11	13	14	16	9	
negative	3	0	1	0	0	

The superior supply groups in most of the urban areas have faster growth when the boundary point is chosen lower down the ranking (i.e. growth rates tend to increase from left to right in Table 4b), the remainder have a peak growth rate for the superior grouping which combines internal pipes and wells. The pattern of change of growth rates across different boundary points is less regular in rural areas: only eight regions display the regular urban pattern of faster growth across lower ranking boundaries; one, Mbeya, has a regular pattern but in the opposite direction; the rest show evidence of an overall shift towards both internal and external wells.

This data configuration allows us not only to study the relative growth or decrease in the more desirable forms of water supply, but also to examine the relationship between growth in superior water supplies and the pace of population growth. This can be done by means of simple regression analysis, treating the growth in the superior water supply group as the dependent variable, and total household growth as the predictor.

The slope of the regression line tells us whether rapid population growth is associated with a less favourable supply situation (regression coefficients less than one) as would be predicted by a neo-Malthusian outlook, or a more favourable situation (regression coefficients greater than one) which is what Boserup's innovation hypothesis might lead us to expect, or what would occur if the availability of a convenient water supply served as an attractor to internal migrants.

Two growth models were tested using this data – the simple, univariate model described above, and a bivariate model, in which the second independent variable was the baseline (1978) value of the proportion of households with the superior supply. The baseline proportions were also treated as the dependent variable in a multivariate model, in which the explanatory variables used were rainfall, an index of agricultural potential, population density, proportions of the regional population living in urban areas, and literacy level. The object of this exercise was to try and discover whether there were any easily measured predictors of the evolution of supply patterns in the different regions up to 1978. To allow for the different sizes of the populations in each region, the values used in the regressions were weighted by the 1978 number of households.

In both the growth models, the constant term in the regression shows whether there has been a general tendency for the number of households using the superior source grouping to increase or decrease over the intercensal interval. With regard to the relationship of source change to population growth, our "null hypothesis" in both models is that water provision from each source exactly keeps up with population growth. The significance tests on the coefficient of the household growth variable therefore determine whether it is significantly different from one rather than from zero.

In the case of the model which includes the baseline proportion with a superior supply, the null hypothesis is that the 1978 levels of use of different sources represented an environmental or demand equilibrium for each region, so that in the absence of population growth, the sources would continue to be exploited at the current levels. Positive values of the coefficient for the baseline proportion of the superior supply would indicate that regions which had already achieved relatively high levels of use of the better sources were the ones in which growth in their use was proceeding fastest. This could be explained in several ways: that these sources were relatively easy to develop, and environmental constraints to their further development were not important at present, or simply that demand for these sources was high in areas in which they were relatively widely used. It would not be possible to discriminate between supply and demand side explanations without collecting additional data and constructing a more complex model. Negative values of the same coefficients would indicate that growth in the better sources of supply was proceeding fastest in regions in which these were relatively underdeveloped. Again, both supply and demand factors could be used to explain this. Since the growth in use of a source grouping which is already used by almost the entire population would be constrained by the growth of the whole population, we would expect these coefficients to decline as cut-off values for the superior source were made lower down the ranking, thereby including a larger fraction of the population in each region.

## 5. Regression Analysis Results

Examining first the simple score data presented in Table 3, we can regress the changes in the scores against their baseline values and the overall growth in the number of households in the intercensal interval. The results are shown in Table 5. In both urban and rural areas, the coefficient of the base line score is negative and significantly different from zero, indicating that the largest declines in the water source score have occurred in those regions where the scores were highest in 1978. In urban areas, there is a significant negative relationship with the growth rate – changes are worse in the more rapidly growing urban areas, but this is not the case for rural areas, where the positive coefficient has no statistical significance. However, these results tell us nothing about which types of source are becoming more or less prominent, and whether, in the case of urban areas, population growth is actually associated with an absolute decline in provision from the best ranked sources. For answers to these questions we must examine the statistical relationship between population growth and growth in the grouped water supply categories.

**Table 5. Regression Results for Water Supply Scores**

Dependent Variable	Prob > F of model	independent variable household growth		independent variable baseline level
		const. signif.	coeff. signif.	coeff. signif.
rural supply score change	0.001	1.71***	0.51	-0.90***
urban supply score change	0.027	1.19**	-0.35**	-0.38**

\*\* difference significant at 5 per cent level of probability

\*\*\* difference significant at 1 per cent level of probability

The results of regressing the growth rates of households with superior supplies at different boundary points against the overall growth rate for households are shown in Table 6. The comparative regularity in the behaviour of urban areas is reflected in the probability values of the F-statistic which indicate the overall explanatory power of the model: the lower values for urban areas indicate a stronger relationship between dependent and independent variables.

In the regressions for urban areas, the constant terms are all positive, but not significantly different from zero, and the coefficients of the overall growth variable are all less than one, though only two of the relationships are significantly less than unity. In the rural area regressions, the constant terms are all negative, though only one is significantly different from zero, and the growth coefficients almost all greater than one, but not significantly so.

**Table 6. Grouped Growth Regression: Model I. Growth in superior water supply compared with overall household growth**

**Rural areas**

Dependent Variable	Prob > F for model	independent variable: household growth	
		constant signif. diff. from 0.0	coefficient signif. diff. from 1.0
superior group growth			
in piped	0.368	-0.44	1.44
in well	0.266	-0.00	1.62
in other	0.391	-0.08	0.99
out piped	0.010	-0.24**	1.55
out well	0.000	0.00	1.22

**Urban areas**

in piped	0.057	0.09	0.44**
in well	0.007	0.11	0.67
in other	0.006	0.08	0.67
out piped	0.000	0.03	0.79**
out well	0.000	0.01	0.99

\*\* difference significant at 5 per cent level of probability

Figures 1 and 2 illustrate the regressions of growth in the number of households with an internal water supply or a piped supply of any kind against total household growth (the results shown in the fourth rows of the urban and rural panels of Table 6). The continuous lines represent the regression line, and the 95 per cent confidence limits of the prediction. The dashed line is a reference curve – it has a slope of one and passes through the origin, indicating the relationship we would expect if the growth in this level of water supply was exactly keeping pace with population growth. In the rural illustration (Fig. 1), the regression line has a steeper slope than the reference curve, indicating that this level of water supply grows faster in the regions which are experiencing more rapid growth, but because the general pattern is one of decline in this kind of water supply, as exemplified by the negative intercept, the reference curve generally lies between the confidence limits of the regression line, and the difference in slopes is not significant. By contrast, the urban regression slope (Fig. 2) is less steep than the reference line, indicating that the higher the population growth, the less likely it is that growth in this level of water supply will keep pace. The differences between population growth rate and water supply growth are significant, as indicated by the fact that the reference curve lies outside the confidence limits.

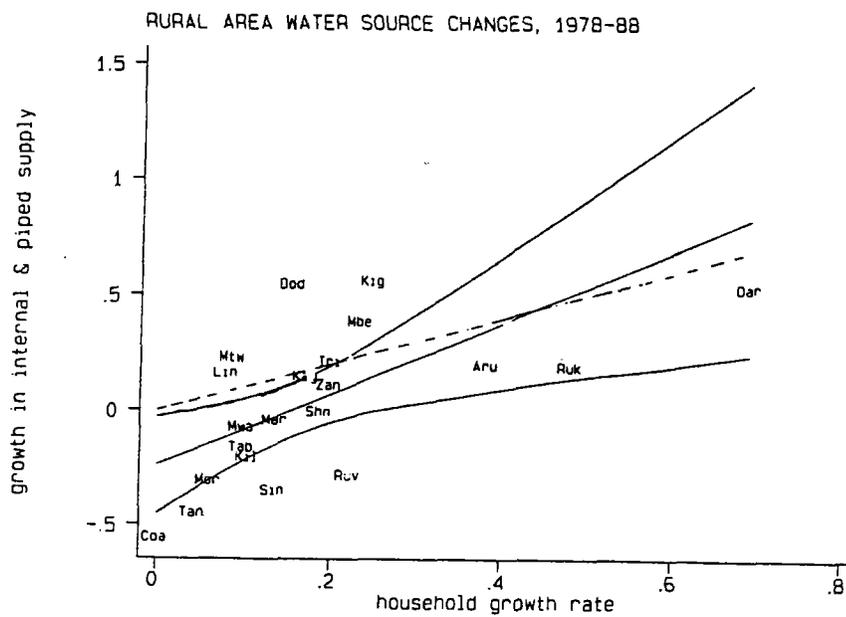


Fig. 1. Regression of growth in the number of rural area households with an internal water supply or a piped supply of any kind against total household growth.

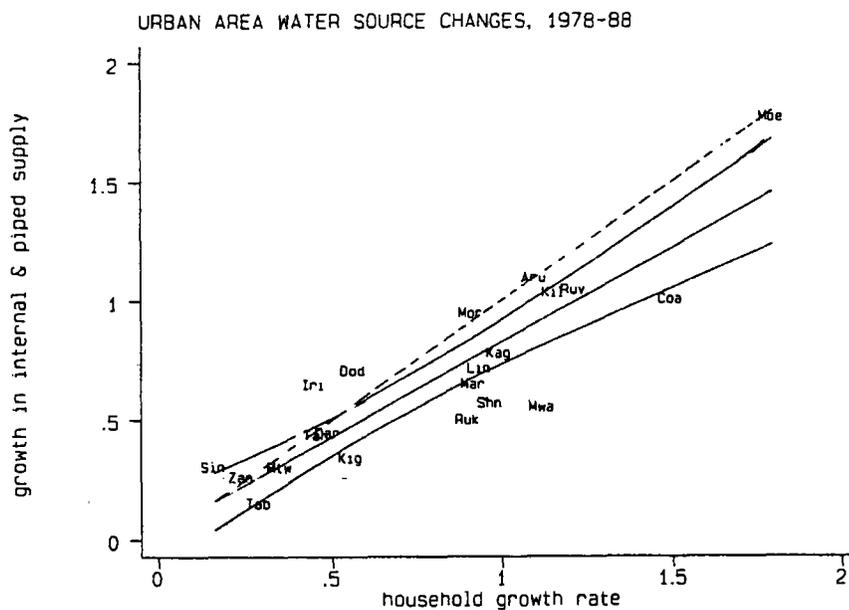


Fig. 2. Regression of growth in the number of urban area households with an internal water supply or a piped supply of any kind against total household growth.

Table 7 shows the results of the bivariate regressions, and the F-statistic probabilities indicate broadly similar levels of correlation for both urban and rural areas, all the relationships being significant at the 10 per cent level, and most of them significant even at 1 per cent. The rural-urban contrasts between the constant terms and the growth coefficients are the same as in the univariate regressions. In the regressions for rural areas, the coefficients for the variables which measure the baseline level of the supply groupings are positive, all highly significant, and decrease in value as the group cut-off point is shifted to include less desirable supplies (and a larger fraction of the total population). For urban areas these coefficients are negative, of varying significance, and show no regular trend over the supply groupings.

**Table 7. Grouped Growth Regression: Model II. Growth in superior water supply compared with overall household growth and baseline supply level**

**Rural areas**

Dependent Variable	Prob > F for model	independent variable household growth		independent variable baseline level
		const. signif. diff. from 0.0	coeff. signif. diff. from 1.0	coeff. signif. diff. from 0.0
superior group growth				
in piped	0.058	-0.78**	1.17	6.80**
in well	0.029	-0.92**	1.45	3.36**
in other	0.000	-1.13***	0.37	3.32***
out piped	0.001	-0.75***	1.23**	1.19***
out well	0.000	-0.79***	1.35***	0.89***

**Urban areas**

in piped	0.083	0.42	0.42**	-0.96
in well	0.004	0.73**	0.65	-1.65**
in other	0.005	0.64*	0.66*	-1.45*
out piped	0.000	0.13	0.79**	-0.11
out well	0.000	0.96***	0.96	-0.95***

\* difference significant at 10 per cent level of probability

\*\* difference significant at 5 per cent level of probability

\*\*\* difference significant at 1 per cent level of probability

The rural part of Dar-es-Salaam region is clearly very different from rural areas in the rest of the country. Table 3 shows that internal piped water supplies in this area grew 6-fold, far faster than in any other area, rural or urban, but from a very low base – in 1978 this area had the second lowest proportion of households with this supply in the whole country, as can be seen in appendix Table A1. Numerically, the rural areas of Dar-es-Salaam are not particularly important – less than 1 per cent of the rural population of the whole country live there, (but just over 10 per cent of the population of the Dar-es-Salaam region). In most of the regressions for rural areas Dar-es-Salaam

was either a prominent outlier, or exerted very high leverage. The rural area regressions were therefore repeated without Dar-es-Salaam, and the results shown in Table 8.

**Table 8. Grouped Growth Regressions for Rural Areas Without Dar-Es-Salaam. Growth in superior water supply compared with overall household growth and baseline supply level.**

**Model I**

Dependent Variable superior group growth	Prob > F for model	independent variable household growth		independent variable: baseline level coeff. signif. diff. from 0.0
		constant signif. diff. from 0.0	coefficient signif. diff. from 1.0	
in piped	0.594	-0.37	0.93	
in well	0.275	-0.26	1.77	
in other	0.460	-0.07	0.96	
out piped	0.013	-0.26**	1.66	
out well	0.001	-0.01	1.27	

**Model II**

in piped	0.080	-0.71**	0.67	6.79**
in well	0.035	-0.94**	1.58	3.36**
in other	0.000	-1.11***	0.14	3.37***
out piped	0.001	-0.76***	1.32	1.18***
out well	0.000	-0.87***	1.49*	0.97***

\* difference significant at 10 per cent level of probability

\*\* difference significant at 5 per cent level of probability

\*\*\* difference significant at 1 per cent level of probability

In fact, excluding Dar-es-Salaam makes surprisingly little difference to the observed relationships. Most of the correlations are slightly weaker, as shown by the modest increases in the probability of the F-statistic. It is clear that in rural areas, the rate of change in water use from the most desirable sources is much more strongly correlated with historical patterns of use than with population change.

Table 1 and appendix Table A1 show that household size increased in both rural and urban areas between 1978 and 1988, as population growth was faster than growth in number of households at both national and regional levels. Population growth and household growth are very highly correlated, but population growth did not perform as well as growth in number of households as an explanatory variable in the regressions, nor did it provide any further explanatory power if it was included as an additional variable in any of the models. The same was true of mean household size, and increase in mean household size.

The background socio-economic and climate variables were also included in regression models for growth in water supply at various levels of desirability. The only baseline variable to show consistent and significant correlation with water supply change was the rural wealth index, which was negatively correlated with all the growth rates of superior supply in rural areas, no matter where the boundary was drawn, and

most of these correlations were significant at the 5 per cent level. No significant correlations were found for urban areas. Adding the wealth index to the independent variables in regression model II for rural areas did not significantly improve the explanatory power of the models, nor did it change the significance of regression coefficients reported in Table 7.

The baseline values for proportion of households with superior water supply were then regressed against the background variables, to see if the 1978 supply patterns could be explained by these climatic or socio-economic factors. In the rural areas, the only relationship to emerge was a weak negative correlation (significant at the 10 per cent level) between baseline level of water supply and rainfall. This relationship was observed for all the boundaries between superior and inferior sources except for the outside well boundary. This finding indicates that by 1978 internal sources and outside piped supplies were better developed in the rural areas of regions of relatively low rainfall. As for urban areas, the baseline supply levels appeared to be positively correlated with rural density and negatively correlated with proportion of the population in urban areas, but this was entirely due to the two outliers, Dar-es-Salaam and Zanzibar – when the observations for these regions were dropped, no significant relationships were observed.

One other set of regression analyses was tried – regressions of rural baseline supplies and growth in these against their urban equivalents, to see whether the development of rural supplies was an extension of urban development. No significant relationships were discovered here – there is not even any correlation between overall rural and urban growth rates on a regional basis, suggesting that urban growth differentials are determined by inter-regional migration rather than by the scale of migration from rural areas within the region.

## 6. Discussion

The analysis presented above confirms that domestic drinking water supply is deteriorating in both rural and urban areas of Tanzania. When different sources of household supply are split into two groups, "superior" and "inferior", it is only the inferior grouping which consistently grows faster than the total number of households, no matter where the boundary between superior and inferior is drawn. This indicates that the most rapid growth is taking place in the least desirable sources of drinking water – "other external" – that is rivers and river beds, ponds, springs and dams in rural areas, and mobile vendors in urban areas.

However, it is only in urban areas that population growth is seen as a significant factor in the shift towards inferior sources, in so far as the situation appears to be worse in those regions where urban population growth is most rapid. In rural areas, where the changes have in general been more unfavourable than in urban areas, the opposite is true – the shift to inferior sources is strongest in the areas which are growing more slowly, though the relationship is not strong enough to be statistically significant. Furthermore, in rural areas the most favourable changes have occurred in regions which were already relatively well supplied at the beginning of the interval, so there is no direct evidence for the emergence of new environmental constraints to water supply in rural areas. In urban areas the trends are in the opposite direction – the worst

changes have occurred in those areas which had relatively good supply patterns in 1978, though the relationship is not as strong as that observed in rural areas. Since the reforms which increased payment for piped water use in urban areas have only been in effect since 1991, it is very unlikely that cost factors would have lowered demand in areas where supplies were relatively well developed, so we can tentatively conclude that supply side problems are worst in these areas.

These results show that neither the simple Malthusian explanation, nor any of the opposing hypotheses could entirely account for the relationship between changes in water supply and population growth in both rural and urban areas of Tanzania. It seems more likely that cyclical changes are taking place, with different areas experiencing Malthusian pressures and technological innovation in different phases of their development. Thus an area naturally endowed with easily exploitable water resources, or one which is wealthy enough or politically powerful enough to ensure investment in technological solutions, may experience relatively rapid population growth as people are attracted to it from neighbouring regions. In this first phase, relatively good water sources can still be developed or expanded faster than in surrounding regions, even if their growth does not match that of the overall population. As a group, the rural areas of the country would appear to be in this development phase. The momentum of the migratory movement and natural increase in the fastest growing areas may subsequently cause the ratio of people to desirable water sources to become relatively unfavourable compared to that in slower growing areas, and unless there is further investment, these initially better endowed areas may then experience worse changes in water supply. Urban areas as a whole are currently in this phase.

The big question, which is not answered by this analysis, is whether the regions possess enough water resources and whether the country as a whole has enough investment capital to enable urban areas to re-enter the first phase of such a cycle. The migratory component of regional population growth could help to improve the overall water supply situation, if migration was towards areas with better natural water endowments, or if the concentration of population in urban areas made the provision of piped water more economical. However continuing high rates of natural increase can only make it more difficult to maintain water provision at current levels, or to effect any kind of improvement.

It is particularly worrying that supplies internal to the compound are declining in rural areas, as there is no evidence that these are being replaced by external piped water sources. The bulk of internal provision in rural areas continues to be provided by wells, but the proportionate use of this source has declined in 8 regions, with an absolute decline in 4 regions: Coast, Singida, Tabora and Rukwa. There is an urgent need for field studies which could investigate whether the loss of internal wells is due to falling groundwater levels, or to contamination due to unsatisfactory sanitation.

It would be interesting to repeat this analysis with a finer geographical breakdown – e.g. using data aggregated at the district level for the mainland (103 districts) and the regional level for Zanzibar (5 regions) would give us up to 108 observations of each variable rather than the 21 used above, though there would be some missing data problems, as a few boundary changes have occurred at the district level between censuses, and not all districts contain both rural and urban areas. Such an analysis would also help to identify areas in which mechanical failures of piped supplies were

the major cause of an overall decline in the distribution of households by water source. However, the district level tables of water source data were not published for 1978, and we have not yet been able to locate them in the archives of the census office.

Looking ahead to the next census, it would seem appropriate to include a question on payment for water, since this is becoming more widespread, even in rural areas, and even for water which is not piped into the dwelling. It would also be useful to distinguish between traditional wells and modern boreholes as sources of drinking water supply, as this would give a better indication of the extent of use of technological solutions in different parts of the country. A further question asking whether the main source of drinking water was adequate for both wet and dry seasons would give some indication of the reliability of modern and traditional sources. An analysis of the information provided by expanding the questions on water supply would allow the government to begin to monitor the progress of its new policy of providing access to clean water at an affordable price.

## Footnote

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## Appendix Tables

Table A1. Percentage Distribution of Households by Water Supply, 1978 and 1988

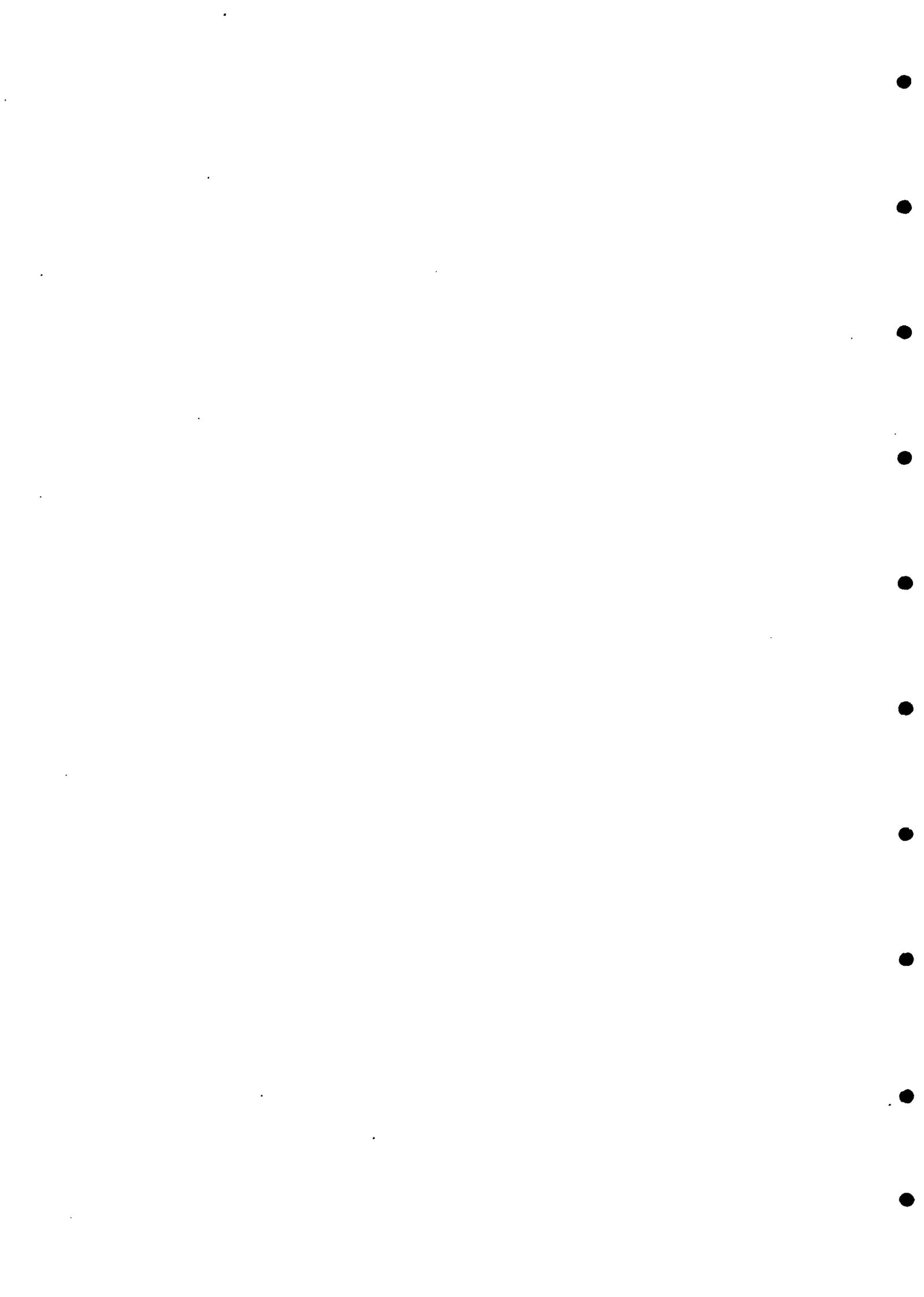
RURAL AREAS	Year	Total			Internal			External			Household size
		households	pipcd	well	other	pipcd	well	other			
Tanzania	78	2994456	11.6	18.9	10.1	16.1	27.5	15.8	4.9		
	88	3480233	5.8	22.3	6.8	12.7	38.2	14.2	5.4		
Dodoma	78	188837	8.8	15.8	1.4	28.8	21.9	23.3	4.7		
	88	218168	14.0	41.0	7.6	9.8	21.5	5.9	5.1		
Arusha	78	156949	24.9	6.4	10.8	29.9	7.6	20.4	5.3		
	88	217398	8.3	16.0	12.1	24.9	18.7	19.8	5.5		
Kilimanjaro	78	153189	40.1	4.1	26.6	20.8	0.3	8.1	5.3		
	88	169371	16.5	6.2	7.0	34.7	7.8	27.8	5.5		
Tanga	78	187488	20.0	2.9	3.9	50.5	16.9	5.8	4.4		
	88	195476	4.8	10.2	5.9	18.6	43.5	16.9	5.4		
Morogoro	78	169743	20.4	12.9	5.0	33.0	20.2	8.5	4.5		
	88	181126	2.5	17.8	4.9	19.9	32.3	22.0	5.3		
Coast	78	111267	25.8	43.7	0.2	11.0	14.9	4.4	4.2		
	88	111227	2.8	19.6	1.1	10.9	59.4	6.3	4.8		
Dar-es-Salaam	78	19129	2.1	26.7	0.0	33.2	38.0	0.0	3.7		
	88	32388	8.1	20.4	0.8	26.2	44.1	0.4	4.4		
Lindi	78	107037	4.8	26.7	1.4	6.2	58.5	2.4	4.4		
	88	115499	5.3	25.3	1.6	9.2	50.0	8.5	4.7		
Mtwara	78	156003	4.9	16.5	2.5	28.3	33.9	13.9	4.3		
	88	169481	10.6	17.5	0.6	29.4	40.9	0.9	4.4		
Ruvuma	78	98569	1.4	19.8	20.9	13.2	37.7	7.0	5.2		
	88	120467	1.1	16.5	0.8	13.2	58.5	10.0	5.3		
Iringa	78	188252	22.6	23.6	12.1	10.0	18.4	13.3	4.4		
	88	225640	15.2	29.9	12.2	10.6	24.9	7.1	4.7		
Mbeya	78	195649	3.8	17.3	17.1	8.7	33.1	20.0	5.0		
	88	241478	6.7	29.2	6.8	9.2	35.3	12.8	5.0		
Singida	78	120567	6.2	32.0	6.6	7.5	33.8	13.9	4.6		
	88	136819	1.3	19.3	3.3	5.2	56.4	14.5	5.3		
Tabora	78	138432	4.7	39.2	0.2	1.0	39.9	15.0	4.8		
	88	152031	0.9	29.6	0.8	2.3	63.3	3.0	5.8		
Rukwa	78	76845	6.7	13.1	9.0	8.6	42.2	20.4	5.2		
	88	113789	0.3	8.7	1.8	18.7	45.7	24.8	5.3		
Kigoma	78	105322	6.5	11.1	20.8	8.7	11.6	41.3	5.5		
	88	131428	9.0	18.2	17.8	13.2	16.2	25.6	5.7		
Shinyanga	78	214536	5.0	27.3	13.9	4.6	27.4	21.8	5.9		
	88	254661	1.5	30.3	5.8	4.1	46.9	11.3	6.5		
Kagera	78	215965	2.4	8.0	28.6	6.2	26.7	28.1	4.4		
	88	252894	1.4	21.9	18.0	2.4	23.5	32.9	4.9		
Mwanza	78	208382	5.7	26.2	4.6	3.3	44.5	15.7	6.2		
	88	228938	0.6	24.2	4.7	3.4	57.2	9.9	6.7		
Mara	78	106109	2.1	13.9	4.7	13.4	48.4	17.5	6.3		
	88	120698	1.3	19.2	4.0	3.7	58.7	13.1	7.0		
Zanzibar	78	76186	13.2	34.2	1.0	11.5	36.6	3.5	4.2		
	88	91256	4.2	30.5	3.4	16.4	41.9	3.5	4.5		

Table A1 (Contd.).

URBAN AREAS	Year	Total		Internal			External			Household size
		households	pipcd	well	other	pipcd	well	other		
Tanzania	78	560337	34.0	2.6	1.2	54.1	5.7	2.4	4.2	
	88	939405	27.4	5.7	0.6	52.1	11.5	2.7	4.5	
Dodoma	78	18566	38.8	1.1	0.8	47.8	6.7	4.8	4.3	
	88	29125	44.8	3.7	0.3	46.3	3.3	1.3	4.5	
Arusha	78	18877	41.7	1.3	0.7	50.6	3.1	2.6	3.9	
	88	39678	23.3	4.4	1.6	64.0	3.0	3.6	3.9	
Kilimanjaro	78	16969	56.3	0.5	0.5	40.7	1.0	1.0	3.9	
	88	36601	26.6	0.9	0.6	63.5	2.4	6.0	4.3	
Tanga	78	32950	47.0	2.4	0.6	46.8	2.6	0.6	4.3	
	88	48054	37.1	3.9	0.7	52.4	3.4	2.5	4.6	
Morogoro	78	31645	32.6	2.4	0.8	50.4	8.5	5.3	3.5	
	88	60646	34.0	9.5	1.2	42.0	9.7	3.5	4.4	
Coast	78	7985	44.2	3.8	0.1	48.1	3.7	0.1	4.4	
	88	19970	15.3	13.9	0.1	47.2	14.5	8.9	4.7	
Dar-es- Salaam	78	188405	31.4	0.0	0.9	66.7	0.8	0.2	4.0	
	88	281083	28.3	2.5	0.1	63.8	5.1	0.2	4.3	
Lindi	78	11734	27.0	1.9	0.1	56.8	13.0	1.2	4.3	
	88	22731	15.3	11.5	0.4	48.1	23.8	1.0	4.2	
Mtwara	78	21715	14.4	3.6	0.7	60.6	19.1	1.6	4.3	
	88	29366	15.9	8.9	0.2	50.3	22.3	2.4	4.3	
Ruvuma	78	8940	25.3	6.6	2.7	40.8	13.9	10.7	4.9	
	88	19812	25.8	6.3	0.9	36.0	30.2	0.8	4.5	
Iringa	78	18810	28.3	4.6	3.8	50.5	9.0	3.8	4.2	
	88	27297	29.2	4.4	0.3	63.9	1.6	0.6	4.2	
Mbeya	78	22101	27.9	2.6	2.3	54.1	7.4	5.7	4.4	
	88	61885	27.5	6.9	1.3	49.7	11.3	3.2	4.3	
Singida	78	12872	17.6	8.9	2.2	38.9	24.2	8.2	4.4	
	88	14946	18.8	14.6	0.1	41.4	21.2	3.9	4.5	
Tabora	78	24721	29.3	11.1	1.7	49.6	8.0	0.3	4.3	
	88	31901	22.3	9.7	0.4	48.1	19.4	0.1	4.7	
Rukwa	78	11130	22.1	6.3	1.4	50.5	15.6	4.1	4.5	
	88	21165	18.9	3.6	0.0	40.0	31.0	6.4	4.6	
Kigoma	78	12219	31.6	1.5	1.0	58.4	1.7	5.8	5.1	
	88	19031	31.9	6.0	0.1	40.7	15.7	5.7	5.3	
Shinyanga	78	12741	45.9	2.9	2.8	41.3	5.4	1.7	4.2	
	88	25077	28.2	7.0	3.0	35.1	22.2	4.6	4.5	
Kagera	78	8328	26.6	1.3	5.3	35.3	5.3	26.2	3.6	
	88	16614	15.4	8.6	1.0	35.5	17.1	22.4	4.1	
Mwanza	78	32336	26.6	6.1	1.4	55.7	9.2	1.0	4.4	
	88	68558	12.8	9.3	0.4	42.5	30.1	4.9	4.9	
Mara	78	10538	31.8	7.2	0.2	48.3	9.7	2.8	4.9	
	88	20238	13.5	7.0	0.5	53.3	21.8	3.9	4.9	
Zanzibar	78	36755	59.2	3.4	0.1	30.7	6.2	0.4	4.2	
	88	45627	55.5	6.1	0.2	31.7	6.2	0.2	4.9	

**Table A2. Baseline Values of Socio-Economic and Climate Variables**

Region	Rural wealth rank 1971	Rainfall 1971	Population density 1978	Percent urban 1978	Percent literate 1978
Tanzania		840	17.2	13.8	35.4
Dodoma	1	500	21.6	8.8	35.4
Arusha	16	600	10.4	8.0	29.1
Kilimanjaro	18	650	63.5	7.5	66.7
Tanga	17	800	33.5	14.1	44.7
Morogoro	19	1000	11.4	14.4	43.4
Coast	8	900	14.9	7.2	27.9
Dar-es-Salaam	20	1200	81.1	91.3	26.6
Lindi	12	900	7.2	10.1	31.9
Mtwara	7	950	41.3	12.0	38.2
Ruvuma	6	1100	8.2	7.7	54.5
Iringa	12	650	14.8	9.1	38.9
Mbeya	11	850	16.4	8.9	32.9
Singida	1	650	11.3	9.4	33.8
Tabora	12	850	9.4	13.1	22.7
Rukwa	1	950	5.8	11.7	28.9
Kigoma	5	1000	15.8	9.9	28.2
Shinyanga	10	800	25.1	4.2	18.3
Kagera	8	950	34.5	3.4	41.4
Mwanza	12	850	67.3	10.2	26.7
Mara	1	1000	34.6	7.3	40.9
Zanzibar	10	1600	135.5	32.6	25.8



## CHAPTER 22

# THE DYNAMICS OF LAND USE AND LAND-COVER CHANGE AS A MANIFESTATION OF POPULATION-DEVELOPMENT-ENVIRONMENT LINKAGE: WORK-IN-PROCESS

Riga Adiwoso Suprpto

### 1. Introduction

The ongoing interest in studying the linkage between population and environment have brought to the fore a variety of approaches from an array of disciplines such as hydrology, soil sciences, forestry, sociology, demography, anthropology, economics and political science (Ambio, 1992). This has resulted not only in understanding more precisely the differences in which social and natural sciences perceive the linkage, but also, rather frustratingly, a quest for a more interdisciplinary approach. Admittedly, this is not an easy task, since at the same time as scientists try to iron out their differences, there is a "mega-struggle" for claim of superiority of one approach over the other. Nonetheless, one needs to observe this as a necessary process to reach a common interdisciplinary framework.

Studies and classifications of land-cover changes persistently indicate the need for additional information on land use. Most of the land-cover changes are driven by human activities. Initial assumptions contend that such factors as population growth, increasing consumer demands combined with land tenure arrangements, access to credits, shift in trade patterns as well as local inheritance law and customs resulted in different land uses (IGBP Report #24; HDP Report #5, 1993; Turner *et al.* 1990). It is realized that linking human driving forces of land use to land-cover changes is difficult due to the interactive complexity between human and environmental factors. Variabilities in how the linkage manifests itself in different areas has created even more problems in drawing global generalizations on the dynamics of land-cover changes. In addition, simple aggregation of individual responses does not permit the prediction of higher level behavior. Therefore, societal institutions, role in land use and land-cover change need to be seen as human organization over individual actions. This on-going study intends to reveal societal institutions' role in the process of land use change.

### 2. Rationale of the Study

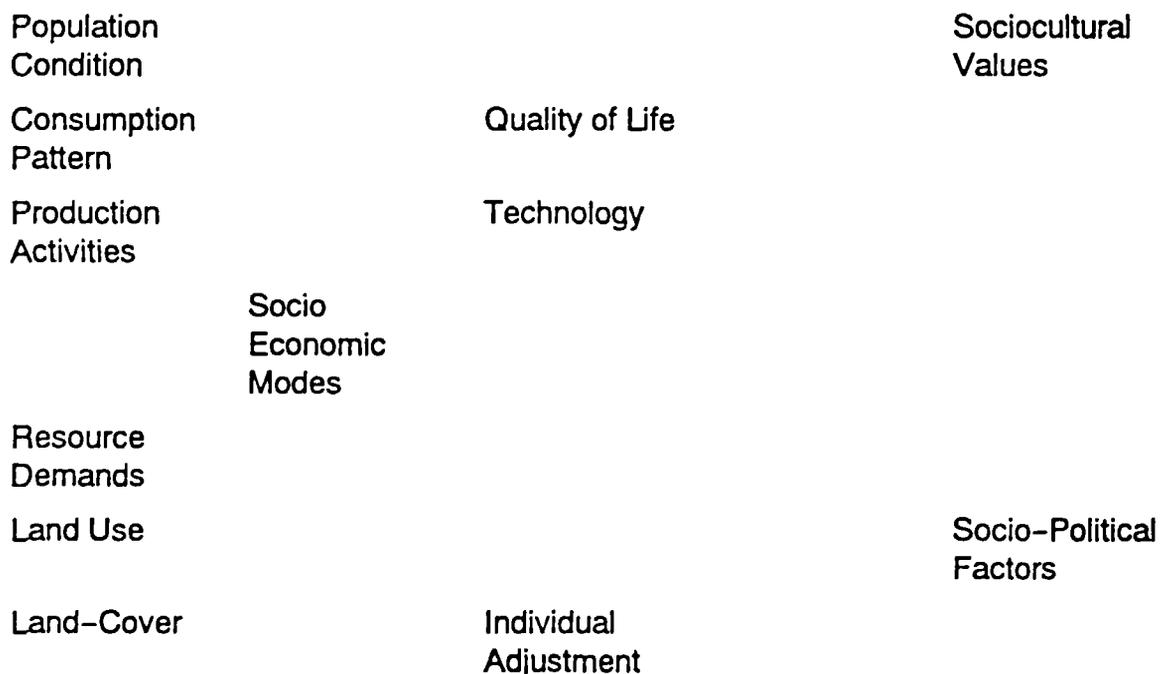
Decision-making processes in the use of lands are often assumed to be based on economic rationale (Kunner, 1992; Mahar, 1989; Ramli, 1993) or demographic rationale (Ehrlich and Ehrlich, 1990; Boserup, 1985; Allen and Barnes, 1985) as well as

technological advancement rationale (Brouwer and Chadwick, 1991) in other words, reflecting the formula of environmental impact:  $I=P.A.T.$  (Impact = Population x Affluence x Technology). Others (Sanderson, 1993; Okoth-Okendo, 1991) have also contended that political economy, particularly the systems of exchange, ownership and control, as well as institutions and government bureaucracies and policies affect or function as driving forces of land-cover conversion. However anthropological studies (e.g. Blaikie and Brookfield, 1987; Tjitrajaya, 1993) indicate that societal values as reflected in the social institutions pertaining to environment are also pertinent in understanding land use changes. In other words, the question is raised about the extent to which decisions in land-cover conversion can be based solely on a singly factor such as economic cost-benefits and are not modified by contextual condition.

This on-going study examines the dynamic process of community decision-making regarding land use. It is intended to examine how the community negotiates internal and external pressures for land use change through institutional mechanisms. It intends to reveal the underlying societal value system governing the environment. Although the study is more data driven than model driven, it is expected to indicate a possible empirical model of the role of societal institution in managing land.

### 3. Methodology

The framework in conducting the study is a modification of a framework proposed previously in which various factors/driving forces have been incorporated (Falkonmark and Suprpto, 1992) as demonstrated in Figure 1.



The framework shows that the population condition (e.g. population growth, migration, as well as structure) does not link directly with land-cover condition, but rather through a series of interlinkages involving human activities. However, such activities are

affected by the value systems prevailing in the society with various intervening factors, such as the perceived quality of life, the technology employed, and the economy of scales within a given society. Although the framework is very general in nature, it defines the focus of a study. In the present case, the main focus is at the interactions between socio-political modes with land use, particularly the cultural values systems of land. However, this does not preclude the possibility to interlink the focus with other sets of factors in the framework.

In addition, the framework itself questions to a certain extent the assumptions underlying the concept of "carrying capacity" employed often by natural scientists, and puts to the fore the concept of "social adaptability". It sees that human societies have certain adaptive capacity towards change. However, the magnitude and speed of change may affect the adaptive ability both at individual level and societal level reaching a certain dysfunctional condition.

The study focuses on the following questions:

- what are the underlying societal value systems towards the environment which encourage or discourage land-use conversion?
- how do societal institutions operate as a mechanism to ensure compliance of the community members? What are the social sanctions operative in a given community?
- how do communities handle competing institutional rules that affect land use?

The study examines six communities in three locations of Indonesia: two communities in West Java, two in Flores, and two in Irian Jaya. It employs comparative case analysis, to identify commonalities and differences in the cases and allow the possibility of drawing a low level generalization regarding the role of societal institutions in land-use changes. While from a purely demographic perspective this may raise the basic question regarding their representativeness, the in-depth study conducted is not intended for qualitative rather than quantitative purposes, so the sampling criterion should not be applied. The on-going study is into its second year and is expected to continue for another. Hence, the results reported are still tentative.

Data were collected through observation and focus group discussion. In addition, unstructured interviews with key informants as well as rapid appraisals were conducted. To be able to gain insights into the value systems, participant observation in various conflict situations were employed.

#### **4. General Historical Background**

The two communities Sawah Lama and Sawah Baru in West Java are located in the outskirts of the JABOTABEK area, and have undergone the rapid land-use change during the last two decades (Fig. 2a). Two other communities, the Iwanggete and Lio, are located at Sikka and Ende respectively, in the island of Flores (Fig. 2b). Two other communities, the Tabbeyan in Kaurek and Sentosa in Unurumguay, are located in Irian Jaya (Fig. 2c).

#### 4.1. West Java Communities

In contrast to the two other locations, the West Java communities studied are semi-urban areas. In the 1960s the area still functioned as a hinterland for Jakarta and its vicinity, particularly supplying vegetables and fruits. A single dirt road connected the area to the local market, which operated mostly at early dawn. Until the early 1970s the population was still fairly homogenous. Ethnically, most of them were Betawi and Sundanese. Economically, most were small-scale vegetable and fruit gardeners. Rice was planted mostly for their own consumption. A limited number of local people (25 persons) worked for an orchid plantation owned by a Jakarta family. Some of the men occasionally became seasonal workers working as laborers for real estate activities in Jakarta.

By mid-1970 drastic changes occurred as the government set up two INPRES elementary schools in the area and compulsory education was enforced. While in the past schooling was confined to a very few members of the community, namely to the sons of the informal leaders (*jawara*) at the apex of the social stratification, the democratization of mass education brought a change in the social configuration. No longer was education confined to them. Nonetheless, because of their socio-economic standing, the sons of the informal leaders still govern the local day-to-day activities either in the capacity of administrative village heads, thus formally assigned authority, or as local leaders. While prior to 1970 the communities knew only of two layers of stratification, the informal/formal leaders and farmers, afterwards another social layer could be found, namely educated unemployed youth aspiring for social vertical mobility. On the one hand, unwilling to work in the field, on the other hand unable to compete for clerical works in Jakarta, these young educated groups take temporary works in the vicinity. Most of them either turned to work, became dependent on the better-off informal leaders, or remained at home unemployed.

In the 1970s the road was enlarged and repaired. Land speculation started to occur, as many expected the area to grow assuming that the Jakarta land use plan was to expand from north to south. Most of the lands were actually purchased by the informal leaders who paid an instalment to the farmers promising them full payments at a later date. Landless farmers continued to tend the land until the owner converted it for housing. Many could not leave or purchase lands in other areas as payments were not fully made by the leaders who expected to resell the lands to real estate developers. As expansion of Jakarta took place from west to east, the economy of the community faltered. In addition, many of the children did not want to work on the land. Hence, most of the lands turned into shrublands rather than remaining as vegetable or fruit gardens. This condition has brought in real estate developers attracted by the low prices of land, and they established low-cost housing for low-middle class workers who commute to Jakarta. At present, real estate housings have taken most of the prime locations. The older local people have been pushed farther into the less productive areas with difficult access to infrastructure. The younger ones remained as laborers in the area or migrated into Jakarta.

## 4.2. Flores Communities

The two communities in Flores, the Iwanggets and Lio, are basically farmers. In contrast to the Sawah Lama and Sawah Baru people, the speed of change taking place is less drastic. The Iwanggete community is located in the mountainous region of Sikka between Ladat mountain in the west and the mountains Tarat Meat in the east. The Lio community is located also in the mountainous area of Detusoko and Wolowaru in Ende. Both are about 500–700m above sea level. Riverflow can be found only during the rain season, and the dry season ranges from 7 to 8 months. The people settled in the mountain areas to avoid malaria rampant in the northern part of the region even though this part is more fertile.

The social structure of the Lio consists of four social strata. At the apex is the *mosalaki* holding most of the power, followed by *aji-ana* family members of the *mosalaki* who protect the interests of the *mosalaki*. The third stratum is *fai walu*, the farmers, and the last stratum is *ata hoo*, the landless peasants.

In contrast, the Iwanggete has only three layers of social strata. The first, *ata dua moan* consists of seven leaders, the landowner, the information leader, the security head, and 4 border leaders. The *ata dua moan* functions as community leaders, reigning over the local people. Most of the power is in their hands. The second layer, *ata riwun gawan* consists of the commoners, and the third one, the *pariah* of the society.

The two communities practice multiple-cropping systems. The main crops are rice and maize. Maize are planted four to five days after the paddy. Dry rice planting method is employed. In addition, they also plant sorghum. Other crops planted in between rice and maize are cassava and sweet potatoes. At present, the people of Iwanggete have shifted their land use into cash crops such as coffee, cacao, and cloves. This shift occurred around the 1970s initiated by the Catholic Mission who organized the Pancasila Farmers Association with the intention to promote crop diversification methods. However, as cash crops provided higher economic returns, the shift into exclusive cash crop cultivation occurred.

In contrast, the Lio community still practices rice and maize planting, although on more a permanent basis than before. The introduction of cash crops was also done but as land tenure was in the hands of the *mosalaki*, the shift to cash crops did not take place.

## 4.3. Irian Jaya Communittee

While the two communities in Flores are rice and maize farmers, the two communities in Irian Jaya are basically forest-dwelling ones. Since 1989 the communities are located within concession area in Jaya Pura district. A joint Indonesian-Korean timber company holds the timber concession in this are for 339,100 hectares of forest. The two communities, the Tabbeyan and Santosa are located in Kaureh and Unumunguay respectively where three rivers run through the area. The soil in the dwellers settlement is considered less fertile than in the marshes and riverbeds where the villagers obtain their sago plants.

Until 1991 the community was quite isolated and was only accessible by two and half days hiking. After the timber concession company built roads, the two communities are accessible by motorbikes.

Historically, the first outsider entering the community was the missionary who arrived in the 1950s and brought about changes to the community. The small dwellers were encouraged to become a more settled community forming larger settlements. This process in turn resulted in a more permanent claim over the land and the natural resources surrounding their settlement areas. As interclan wars were prohibited by the missionaries, the roles of war lords were reduced whereas the roles of the *ondoafi* or clan heads were increased to maintain social networks resulting in more clearly defined clan boundaries.

A drastic change occurred again in the 1980s with the Department of Social Affairs Decree 1983/84 and 1984/85 in which families from the two communities were resettled into two main village settlements. The Tabbeyan were resettled in Taja area whereas the Sentosa were resettled in Jadam area. Many families, having close bounds with their lands, refused to such resettlement as it would reduce substantially their access to their gardens, sago and forest lands since the terrains where the resettlement areas were located were more difficult. Only after they were guaranteed access to extracting sago palms and opening gardens in the surrounding forest, and apparently with some coercive force from the military, did the resettlement process take place (Tjitrajaya, 1993).

As indicated earlier, the main basis needs are fulfilled as dwellers, outing sago, gardening, hunting and fishing. The clan members, whether male or female, participate fully in the processing of sago as well as hunting and gardening. Most of the products are for their own clan consumption.

#### LINE MISSING

*ondoafi* or the clan head families, and clan members. *Ondoafi* regulate their clan members access to forest-lands. As the *ondoafi* holds most of the decision-making power, clan members expect that he will take the lead in negotiating compensations with the timber company. Conflicts in land use are reported to occur regularly.

These general backgrounds of the six communities observed portray the differences in local biophysical as well as social conditions. A closer look at how the community institutions operate indicates several commonalities underlying the land cover change.

## 5. Community Institutions Related To Land Use

### 5.1. West Java Institutions

The social institution regulating land use in the two communities of Sawah Lama and Sawah Baru in West Java has basically been replaced by a modern formal administrative system of individual land ownership; and hence, individual land use. Traces of the old (traditional?) land-use system can still be found among the older generation practising vegetable fruit gardening. While most of the lands are not owned by them any more most of them still tend and benefit from the gardens while awaiting

the owners decision to vacate the land. The gardens are communally tended; that is, the members reciprocally assist each other in tending the gardens on a rotation basis. As fruits, such as jackfruits and durians, do not ripen simultaneously, reciprocal assistance takes place to deliver to the market. Whoever has the turn to go to the market, will bring along marketable goods of others that day. It is the person's responsibility then to seek the best price offer in the market for their commodities. The actual income from the fruit or vegetables is handed over to the owner without any cuts in transportation or opportunity cost.

Should the owner of the land claim the products of the fruit or vegetable gardens, the farmer tending the land will hand over a small/insignificant amount of products as a token of 'ownership' over the land. In other words, the farmers perceive that they still have full rights over their labor tending the gardens.

The influx of newcomers, the residents of the housing compounds/real estates in the area, had opened up new markets for their products. However, the farmers prefer to sell their products directly to the market rather than vending them among the housing compounds, as products are bought in bulk in the market place.

The influx however, has a spillover effect on the younger groups. As most of the houses have servants not employed from the local population, social interactions among the servants and the local youth take place within the compounds rather than at their traditional meeting place where all members regardless of age come to gather. This results in generation gaps with no social institution regulating the interaction yet.

The local people have little to say in the conversion of land into housing real estates, as the community issuers themselves are heavily involved in the land transactions and defining the local informal taxes levied upon the real estate developers. In other words, the land-use system is replaced by a more individual oriented one.

## 5.2. Flores Institutions

In the two communities in Flores, traditional land management still prevails for the total planting cycles of rice and maize. Social sanctions take place for non-compliance to regulations regarding prohibition to:

- a. cut trees in other people's cropland,
- b. grazing on land left to fallow,
- c. vegetation burnings to forests for future croplands,
- d. omit the responsibility to replant used croplands,
- e. omit the responsibility to build terraces/dams to prevent land erosion.

The degree of sanctions depends on the level of offence committed. It ranges from simple warnings to monetary compensations. In order to reestablish equilibrium within the community between the offender and the offended, rituals are conducted. The offended party consists of two sides, the person/family and the land or soil itself. Towards the person/family the offender needs to offer compensation be it in monetary or labor terms. Towards the land, the higher the offence the more complex the ceremony that needs to be conducted. Among the Lio, the *mosalaki* or the community leader defines the sanction, while among the Iwanggete the seven leaders of *ata dua*

*moan* serving as community executives have to agree on the level of offence as well as the sanction.

While in the past the *ata dua moan* of the Iwanggete had the power to assign lands for farming which were rotated among them, with the new administrative system of private and individual property rights they lost their power as the concept of communal ownership was eliminated. However, among the Lio where decisions about land use is in the hand of the *mosalaki*, single person assignments of lands for farming by the *mosalaki* still takes place. In other words, communal ownership can prevail as long as it is congruent with the new administrative system.

Land-cover change, in this case the shift to cash crops among the Lio as a crop diversification strategy introduced by the Catholic missionaries failed, as the role of the *mosalaki* in defining as well as assigning land use still prevails. On the other hand, among the Iwanggete such as introduction was accepted, as the community executives power over land ownership and land use has diminished. In other words, local contextual factors seem to play significant roles in defining land-use changes.

### 5.3. Irian Jaya Institutions

Forest ownership in Tabbeyan and Sentosa in Irian Jaya is vested in several patrilineal and exogamous clans. According to their institutional arrangements, a person has access to obtain or use forest resources belonging to his/her clan, mother's clan, grandmother's clan, and wife's or husband's clan. Such local arrangements might relate to the fact that there have been extensive social relationships among the various clans through marriage and the attendant exchange of presents. Members of a clan have tended to seek intermarriage with members of as many other clans as possible within a large area. Marriage among most clans in Irian Jaya, according to van Baal (1953), has tended to be patrilocal. However, there have been no clan houses, the newly-weds usually move into their own house (Adim, 1963).

Access to forest resources can be gained by non-members who are granted use permits by heads of the clans. This has also been distributed and controlled by the heads of the clans, and tightly guarded by clan members. In the past, the clan members could severely punish those who were caught as trespassers on the scene, but nowadays severe sanctions of trespassers by resource owners have been suppressed by the military. The owners are only allowed to chase away the trespassers by harsh words.

The presence of the timber company in 1969, in the forest claimed by the Sentosa and Tabbeyan has created social tensions as two different resource ownership systems exist within a given area. Conflict incidences indicate that local ownership systems not only regulate the use of forest resources, but also define the environmental management system of the land and the forest, such as which sago trees to leave and cut, and cyclic planting of the gardens. It seems that the prevalent societal values regard the forest as specific clan livelihood resources. Under the traditional view the plants are their resources. Therefore, timber cutting by the timber company is seen as violating their property rights, hence the frequent compensation disputes. The value of the forest as livelihood resources persists as changes occur. When the company employs security guards, conflicts occurred when the "wrong" persons were assigned

to forest areas in which they do not have the clan-use-right. Those with the clan use-right claimed that they were the ones who should benefit from the income as security guards for these areas.

As the people become more exposed to market forces as well as a more monetized society, increased demands occur for monetary compensations for the trees cut. Even if the timber company has paid the local government in Jayapura as local taxes, the people do not see this as benefiting their community, but the community of Jayapura, the people of Sentani and Tobati, not the people of Tabbeyan and Sentosa. The local people perceived that if the timber company had paid the Tobati and Sentani, then they should cut the Tobati's and Sentani's trees, not theirs.

Evidently, changes are taking place in these communities. In the process of adapting to the change, traditional values of land and land tenure systems still continue. While present conflicts are mainly between the local people and the timber company, as the dwellings become more accessible by road, increased conflicts with outside hunters will occur.

## 6. Discussion

Several tentative conclusions can be drawn from these cases:

- a. Urbanization occurring in West Java, which changes the land cover into housing estates, tends to displace older local people further away from the locus of activities. The younger educated ones tend to migrate into the inner city/Jakarta looking for jobs rather than remaining in the area, or seasonally returning to the area where their families live. Population characteristics change into ethnically more heterogeneous but socially more homogeneous.
- b. In the case of West Java and Irian Jaya, the presence of better roads creates circular migration. However, in the case of Irian Jaya, clan-social-network dictates the area to which they migrate circularly.
- c. Land cover crop changes occur only when there is a certain congruency between the existing system and the new system.
- d. In all cases, the environment serves as livelihood resources to which local management systems are applied.
- e. More settled agricultural practices take place when more labor and time are demanded by the crops planted or when the crops are considered to provide higher monetary rewards.

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## CHAPTER 23

# IMPACTS OF GLOBAL SEA LEVEL RISE ON CALIFORNIA COASTAL POPULATION RESOURCES<sup>1</sup>

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### 1. Objectives

Global effects of human populations, organizations, and technologies upon the environment and subsequent feedbacks to populations now receive attention from demographers (Clarke, 1991). To our knowledge, coastal erosion rates, sea level rise and population changes have yet to be integrated into local resource, risk assessment and social impact models. Our objectives are as follows:

- (1) We will describe recent population changes in California counties and projections for California coastal, bay and delta counties from 1990 to 2040.<sup>2</sup>
- (2) We will delineate a preliminary enhanced-risk coastal zone on the Oxnard Plain of Ventura County, California, for potential sea level rise related hazards for the years 1990 to 2040.
- (3) We will make an initial assessment of potential impacts of sea level rise and identify some possible mitigation measures. We will describe these circumstances for the Oxnard Plain.
- (4) We will revise population projections for coastal areas of California to take into account the shrinking land base, including that attributable to a future sea level rise.
- (5) We plan to develop a protocol for risk assessment in other coastal, bay, and delta areas in California and elsewhere, and identify potential mitigation measures to reduce impacts of sea level rise on population.

We report our activities to date concerning the first three of these objectives. This is a report of research in progress; our analysis is illustrative rather than definitive. Like other attempts to describe population-environment relations, our preliminary results vary according to the level of aggregation of our questions and data, the perspectives of the disciplines from which they are asked and the time periods under consideration (Heilig, 1993; Keyfitz, 1993).

## 2. Background

It has been argued that a one meter rise in sea level world-wide could result in more than 50 million environmental "refugees" or displaced persons globally (Jacobson, 1990). The United States, with more than 19,000km of coastline, could be severely affected (Jacobson, 1990), including inundation of both east and west coast wetlands, and beach loss. Early projections of catastrophic sea level rise and widespread coastal inundation are no longer taken seriously. Nevertheless, current projections, at the level of 100cm by 2100, suggest there are many locations where low-lying coastal environments are at risk from even small rises in sea level (e.g. Ellison and Stoddart, 1991).

Population size, as well as production and consumption activities (expressed as gross domestic product per capita), largely determines levels of CO<sub>2</sub> emissions and is described as contributing to global warming (Bongaarts, 1992; Bartiaux and Ypersele, 1993). Global warming may, in turn, lead to sea level rise for two reasons: (1) water expands as it is heated, and (2) glacier and polar ice cap melting could increase the volume of seas (Abrahamson, 1989). Sea level rise decreases the availability of land useful for shelter and subsistence. Natural phenomena may be responsible for some portion of global warming; coastal population increases, however, can exacerbate impacts.

Demographers have recently described population impacts of rising sea level (Nangia and Banerji, 1993). Population-environment connections, including rising sea level, can be expressed as  $\text{impact} = \text{population} \times \text{affluence} \times \text{technology}$ , where  $\text{affluence} = \text{consumption}/\text{population}$ , and  $\text{technology} = \text{impact}/\text{consumption}$  (CICRED, 1992). The Malthusian paradigm suggests that population growth eventually outstrips the ability of the (coastal) environment to provide resources (Malthus, 1798); population increases are assumed to reduce affluence, or reduced affluence is assumed to decrease population (CICRED, 1992). Mitigation includes decreasing levels of consumption and/or technology. Optimists (Simon, 1981) suggest that scarcity limits degradation by driving up (coastal) land prices. Following Boserup (1965), increasing technology such as ocean barriers, may enhance the ability of the coastal environment to support population.

Effects of changes in population and land use "may go in both directions" (Lutz and Holm, 1993). Evaluations of rising sea level-population carrying capacity relationships are hindered by fuzzy concepts, a lack of data, and the fact that definitions of research problems, evaluations of acceptable risks, and specifications and implementation of mitigation measures are all based on social constructions of the reality of risks. The optimist and Boserup paradigms may fit limited (coastal) ecosystems; nevertheless, Malthus correctly anticipated that there are global limits to resources available to support human populations. Following Shaw (1989), we view population growth and affluence-technology determinants of environmental degradation as proximate and ultimate causes, respectively. There appears to be greater resistance to changing the social mechanisms supporting current affluence-technology connections that generate rising sea level than resistance to changing population flows that represent population adaptations (Shaw, 1989). This focuses our attention on the latter.

Two assumptions govern our considerations of impacts of rising sea level on California coastal populations.

First, population growth is a proximate cause of decreasing land availability on the California coast (Koss, Van Arsdol, Jr., and Mongeau, 1987). By 1990, more than 26 million persons, 87 per cent of the state's then 30 million persons, lived in coastal counties (Fig. 1, Table 1). These counties were on the north coast, bay and delta areas, central coast, and south coast. California's coastal county population in 1990 was 20 per cent of the coastal county population of the United States. The sea level rise of perhaps 10–15cm in the past century has had important impacts including beach erosion, recession of wetlands, and salt water intrusion into the bay and delta region, as well as other heavily populated regions (Revkin, 1992).

Second, perceived threats of global warming has raised concerns regarding potential inundation of California coastal areas. Impacts would increase as population increases, and would affect urban and metropolitan areas, which are particularly vulnerable to disaster (Quarantelli, 1987). Redirecting populations away from all affected areas may be unfeasible. Rising sea level is often not perceived as a problem, organizational strategies to mitigate risk are lacking, and land to support relocated populations may not be available. If land is available, an extended time is needed to provide infrastructures, and populations in existing coastal centers must often be accommodated at higher densities and with dwindling resources (Jacobson, 1990).

### 3. Methods

We consider global sea level rise to be a background (macro) characteristic and describe superimposed local (meso) effects. Our methods are as follows:

We first describe population trends and projections for the State of California and the 29 California coastal or bay counties as defined by the Strategic Environmental Assessments Division of the National Oceanic and Atmospheric Administration (NOAA, n.d.i.a). Seven of these counties are non-metropolitan, the remaining 22 are metropolitan; 5 are on the north coast, 13 on the bay and delta region, 5 on the central coast, 6 on the south coast, and 9 are inland counties classified as coastal by NOAA whose populations affect and are affected by coastal ecology (Fig. 1, Footnote 2). Projections from 1990 to 2040 are based on those of the state's Department of Finance Population Research Unit (1993).<sup>3</sup> Long-term projections are necessary due to the need to plan for long-term disruption of coastal populations and infrastructures that may be occasioned by sea level rise.

Second, we delineate an enhanced risk zone. Outcomes of global sea level rise are typically localized and have been described in anecdotal rather than exhaustive terms (Jacobson, 1990). We evaluate future coastal hazard risks, including horizontal (erosional) and vertical (sea level) changes, for the State of California. We will delineate an enhanced risk zone in three steps. The first step is to describe coastal counties and their populations, including inland counties classified as coastal areas or bays (Fig. 1). The second step is to describe coastal census tracts of coastal counties. The third step is to provide an illustrative description of a potential enhanced risk zone within Ventura County. We describe this zone by using US Bureau of the Census

TIGER/line 1992 files to delineate census tracts and then overlay physical features from digital line graphs, based on an analysis of US Geological Service topographic maps.

Third, we will attempt to meld coastal erosion rates, sea level rise projections, population projections, and organizational factors affecting possible mitigation alternatives into risk assessment and social impact descriptions.

#### **4. Population Trends in Coastal Counties**

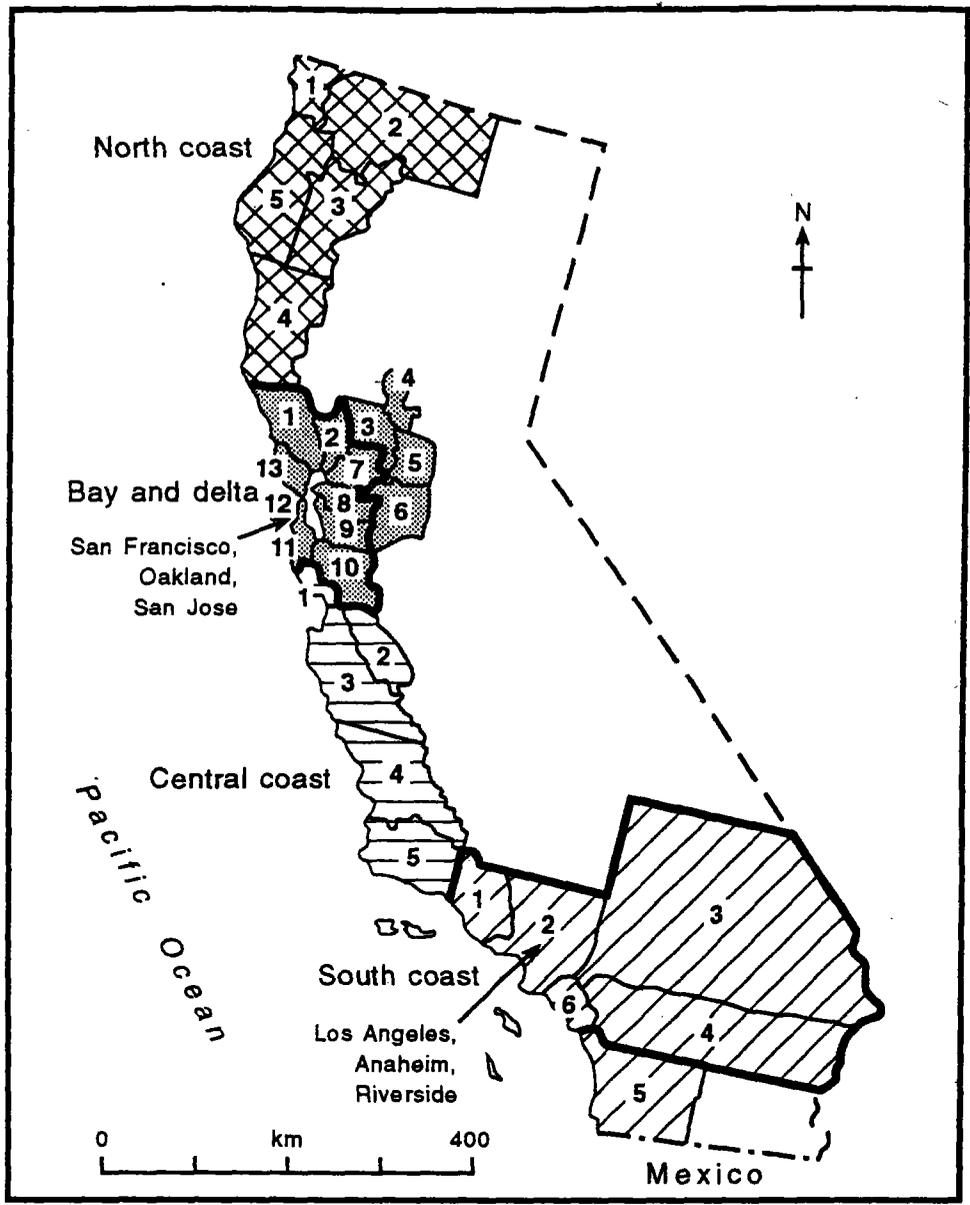
The first step in delineating an enhanced risk zone is to describe California's coastal counties and their populations. California's population historically grew more swiftly than that of the United States as a whole. It increased from less than half a million persons in 1860, when California had one per cent of the nation's population, to nearly 30 million in 1990, 12 per cent of the nation's population. During the 1980s, the state added approximately 6.1 million persons; about 37 per cent from net in-migration and 63 per cent from natural increase.

Population growth in California's coastal counties closely follows that of the state (Fig. 2). High numerical growth occurred in the 1950s, growth was less in the 1960s and 1970s and the highest growth occurred during the 1980s. These trends were apparent in each of the 4 coastal regions.

The total population of the 29 coastal counties (including the 9 inland counties classified as coastal by NOAA) increased by 25 per cent, from 21.0 million in 1980, to 26.3 million in 1990 (Table 1, Fig. 2, Appendix Table 1). Growth for the coastal counties was greatest in the south coast, followed by the bay and delta area. In 1980, the coastal counties contained 89 per cent of the state's population. The land area of these counties accounts for 201,580km<sup>2</sup> or 50 per cent of the state's total land area. The 1990 total populations for the 4 coastal areas were as follows: 280,000 for the north coast, almost 7.8 million for the bay and delta area, 1.2 million for the central coast, and 17.0 million for the south coast.

The share of California population in coastal counties peaked at 90 per cent in 1970, is now decreasing and is projected to continue to decrease. The south coast share was 57 per cent in 1990 and is relatively constant. The bay and delta share was 26 per cent in 1990 and is slowly decreasing. The central coast and north coast shares in 1990 were 4 and less than one per cent, respectively.

California's two largest metropolitan clusters are located on the coast; the San Francisco–Oakland–San Jose Consolidated Metropolitan Statistical Areas (CMSAs) in the bay and delta area and Los Angeles–Riverside–Anaheim (CMSA) on the south coast. Each cluster is integrated into a separate regional economy ranked among the world's largest and each is an economic and social focus for the Pacific Rim, making for metropolitan dominance of the physical ecology of the bay and delta areas and south coast (Fig. 1).

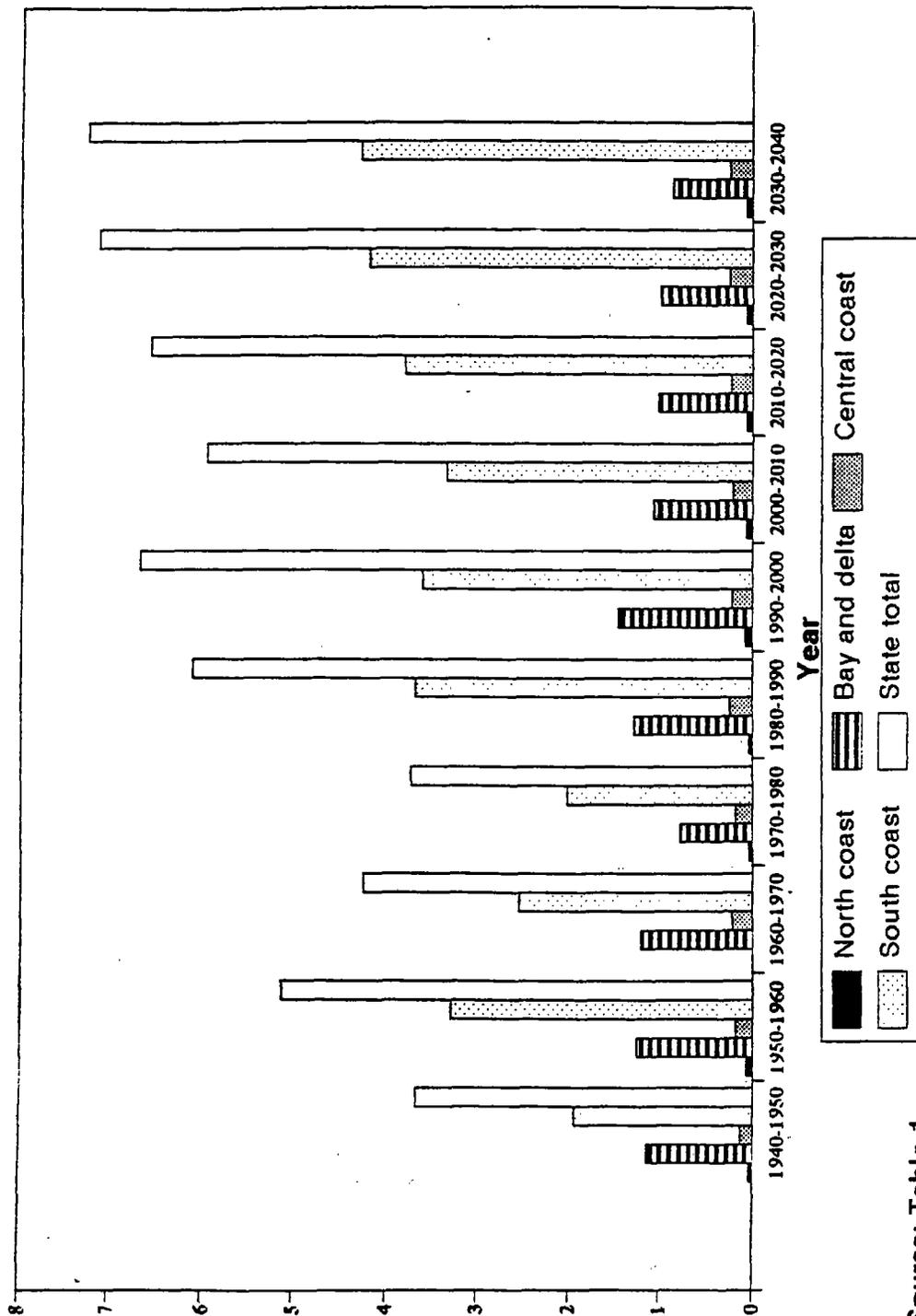


<b>North coast</b>			
1	Del Norte	10	Santa Clara (PMSA)
2	Siskiyou*	11	San Mateo (PMSA)
3	Trinity*	12	San Francisco (PMSA)
4	Mendocino	13	Marin (PMSA)
5	Humboldt		
<b>Bay and delta</b>		<b>Central coast</b>	
1	Sonoma (PMSA)	1	Santa Cruz (PMSA)
2	Napa (PMSA)*	2	San Benito*
3	Yolo (MSA)*	3	Monterey (MSA)*
4	Sutter (MSA)*	4	San Luis Obispo
5	Sacramento (MSA)	5	Santa Barbara (MSA)
6	San Joaquin (MSA)*		
7	Solano (PMSA)		
8	Contra Costa (PMSA)		
9	Alameda (PMSA)		
		<b>South coast</b>	
		1	Ventura (PMSA)
		2	Los Angeles (PMSA)
		3	San Bernardino (PMSA)*
		4	Riverside (PMSA)*
		5	San Diego (MSA)
		6	Orange (PMSA)

**PMSA** Primary Metropolitan Statistical Area  
**MSA** Metropolitan Statistical Area  
**—** Consolidated Metropolitan Statistical Area  
 \* Inland counties classified as coastal

Fig. 1. California coastal counties, by definitions of the U.S. National Oceanic and Atmospheric Administration (NOAA).

**Population growth**  
(Millions)



\* Source: Table 1

Fig. 2. Decennial population growth of State of California and coastal counties: enumerated 1940-90 and projected 2000-40.

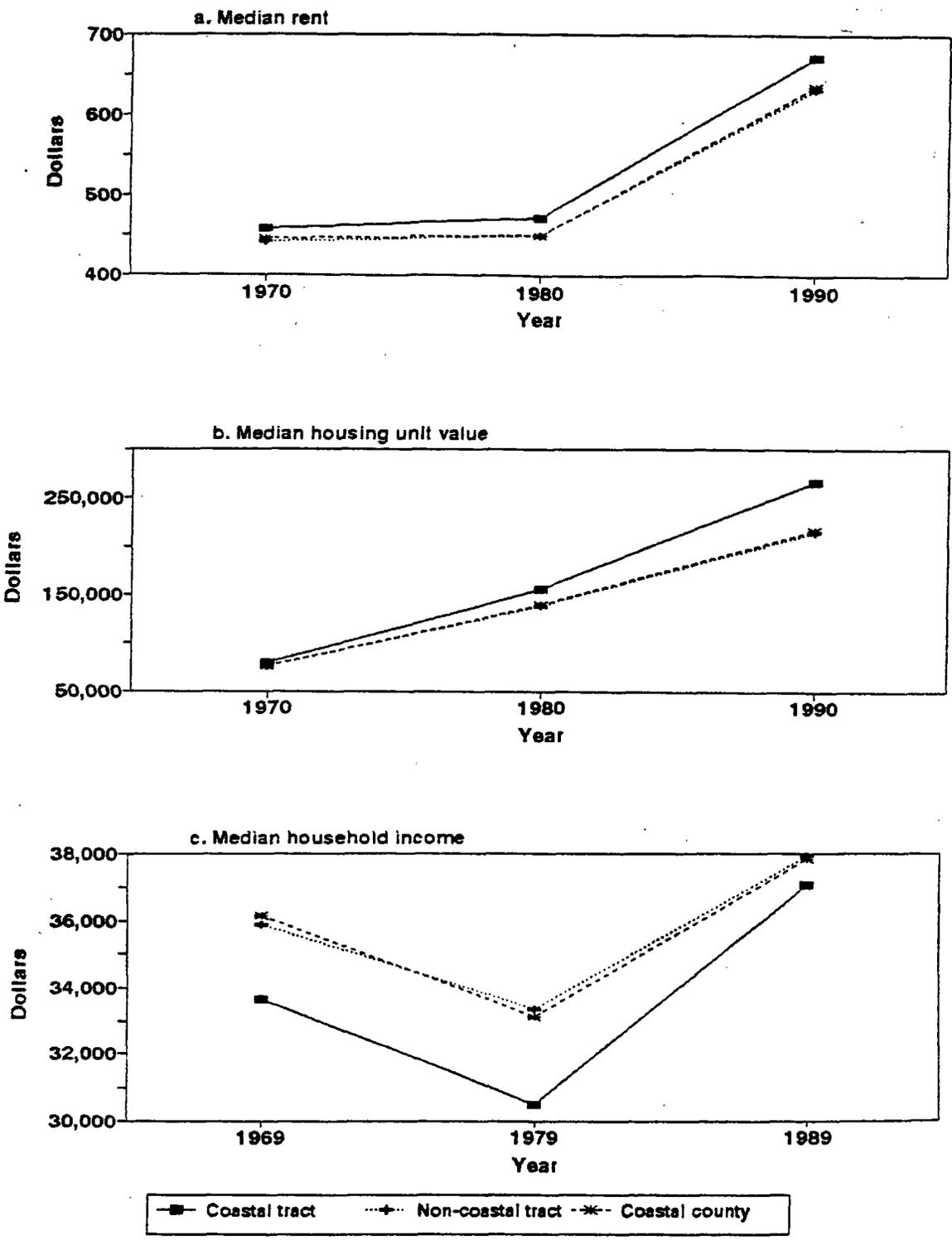
## 5. Population Changes in the Coastal Strip of Coastal Counties

The second step in designating an enhanced risk zone is to describe coastal census tracts in coastal counties. A preliminary analysis of population and housing changes from 1970 to 1990 was carried out for the coastal strip of census tracts along the shoreline of the 20 NOAA defined coastal counties with a shoreline containing coastal census tracts.<sup>4</sup>

The population on the immediate California coast may now be pressing on the residential resource base. By 1990, 7 per cent of the population of the 20 coastal counties lived in the strip of coastal census tracts compared with 8 in 1980 and in 1970. Nevertheless, between 1970 and 1990, the population of the coastal strip increased by approximately 400,000 persons, 1.3 million to 1.7 million, adding 226 persons/km of shoreline. More than four-tenths (42 per cent) of this growth was concentrated in coastal tracts of the metropolitan south coast. In 1990 the percentage of population in the coastal strip was 32 on the north coast, 7 on the bay and delta, 29 on the central coast, and 5 on the south coast.

There is a lack of public lands in California coastal areas, and local governments are also losing some of their abilities to preserve land. Larger populations are now exposed to the risk of rising sea levels and land loss due to coastal erosion and subsidence. Population activities contribute to coastal environmental instability by increasing seacliff or bluff erosion, lowering water tables in coastal areas through irrigation, blocking sand input into shoreline areas, and by contributing to air, land, and water pollution. Approximately 86 per cent of the 1774km coastline of the state for example, is reported to be eroding (Edgerton, 1991). Future loss in the coastal land base, including inundation, when combined with other growth constraints, can reduce the ability of the coastal zone to support human populations. A scarcity of coastal land and current land use restrictions may drive up housing prices and inhibit growth on the coast. The population of the coastal census tracts of the 20 coastal counties increased less rapidly between 1970 and 1990 (32 per cent) than did the population of the inland census tracts (41 per cent) of these coastal counties. The number of housing units increased more rapidly in coastal tracts (54 per cent) than in non-coastal tracts (49 per cent). The differences between population and housing units were greater in coastal than non-coastal tracts.<sup>5</sup>

Median rent and housing unit values (indexed to 1990) were higher for coastal census tracts than for the remainder of the 20 coastal counties and the coastal counties overall for 1970, 1980, and 1990. The median household income (indexed to 1989) was lower for coastal census tracts than for non-coastal tracts and the coastal counties overall during this period (Fig. 3). The difference in housing unit values and median household income between coastal tracts and the remainder of the coastal counties increased more rapidly during the 1980s than in the 1970s. These trends suggest but do not verify a connection between scarcity of coastal land and inhibited population growth.



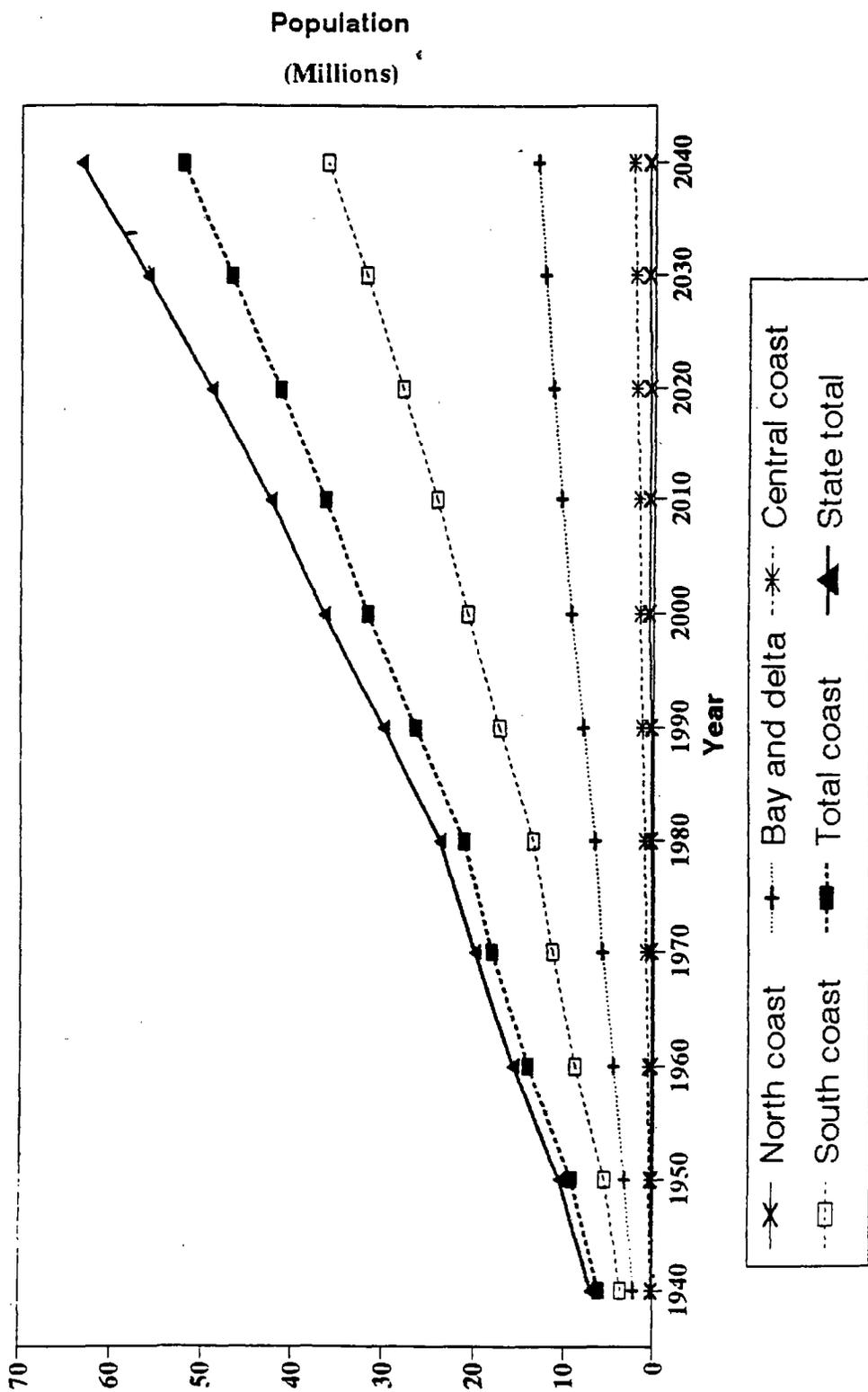
\* Note: Median rent and median housing unit value are adjusted to 1990 consumer price index; median household income is adjusted to 1989 consumer price index. Data are available from authors.

Fig. 3. Median rent and housing unit value, and household income by coastal census tracts, non-coastal census tracts and 20 coastal counties, California, 1970-90.

## 6. Population Projections for Coastal Counties

Significant future population growth in California is projected after the state recovers from the current economic recession. "The state's demographic underpinnings remain strong" according to Morrison (1993). Recent growth provides demographic momentum, migration to California has global origins, and the economic pull of the state is likely to resume, although it is too soon to determine the future mix of non-skilled versus skilled employment (Koss, Van Arsdol, and Mongeau, 1987; Morrison, 1993). Nevertheless, economic downturns, resource shortages, inadequate infrastructures, environmental and social deterioration, earthquakes and other natural disasters, and community growth limitation policies will eventually constrain growth.

The illustrative projections are to help delineate potential impacts of rising sea level and not to emphasize future human numbers. From 1990 to 2040, California population is projected to increase from 29.8 to 63.3 million persons, an increase of 113 per cent (State of California, Department of Finance, 1993) (Table 1, Appendix Table 1). Coastal counties are projected to increase from 26.2 million in 1990 to 52.2 million in 2040, an increase of 99 per cent. Population could more than double on the south coast, increasing from 17 to 36.2 million. In the bay and delta area, the increase could be from 7.8 to 13.1 million (Fig. 4).



\* Source: Table 1

Fig. 4. California coastal population: enumerated 1940–90 and projected 2000–40.

As coastal land becomes more populated, commercial developers and communities attempting to preserve open spaces engage in a conflict over coastal land use restriction. If future population growth saturates the south coast, the bay and delta areas, and the central coast, then further growth is to be expected in inland areas and along the north coast. Urbanization could eventually dominate the entire California coast with the possible exception of the north coast whose timber and canning industries are now too weak to attract newcomers.

## **7. Ventura County Coastal Impacts**

The third step in specifying an enhanced risk zone for sea level rise is to describe such a zone in Ventura County. Our measurements here are preliminary, pending our determination of 1994 mean sea level, which will be used as a benchmark for projecting future sea level rise. Rising sea level affects the Ventura County coastal zone ecosystem in several ways, including reducing fresh water supplies, accelerating beach and cliff erosion, reducing wetlands, dunes, and protective shoreline, and releasing soil bound chemicals on agricultural land. The sandy barrier beach; which advanced by more than 150 m over the last century (Hamblin, 1951), is currently retreating as a consequence of dam and break water construction and sand mining activities. The enhanced risk coastal zone here comprises a broad alluvial lowland area of approximately 405km<sup>2</sup> the Oxnard Plain, with 28km of shoreline between the Ventura River and Point Mugu (Griggs, 1985), including an area overlying a declining aquifer (California Department of Water Resources, 1967) (Table 2).

Due to its low elevation, much of the Oxnard plain would be affected by sea level rise; the census tracts immediately bordering the ocean are considered to be an enhanced risk zone particularly subject to rising tides (Fig. 5). Natural ecosystems are not the only potential casualties of rising sea levels; also threatened are residential structures, sewage treatment plants and other commercial facilities (Griggs and Lauret, 1985). Significant population displacement and property loss could occur in the enhanced risk zone. The coastal census tracts contain high density housing, major resort and hotel complexes, three harbors (Port Hueneme, Channel Island Harbor and Ventura Harbor), and a Marine Corps base at elevations estimated as <3m above sea level, excluding high tide measurements.

**Table 2. Summary data for Ventura County, coastal and non-coastal tracts, Oxnard Plain, and preliminary enhanced risk zone, 1990**

1990	Total	Coastal tracts	Non-coastal tracts	Oxnard plain	Preliminary enhanced risk zone
Total population	668,666	122,248	546,418	326,871	40,097
Persons per room	0.54	0.64	0.52	0.58	0.47
Occupied housing units	217,298	36,662	180,636	104,324	14,745
Persons per occupied housing unit	3.08	3.33	3.02	3.13	2.72
Vacant housing units	11,180	3,418	7,762	5,786	2,419
Persons in owner-occupied housing units	435,666	63,332	372,334	189,905	18,816
Persons in renter-occupied housing units	219,937	54,968	164,969	128,504	19,024
Owner-occupied housing units	142,262	19,138	123,124	61,624	6,796
Renter-occupied housing units	75,036	17,524	57,512	42,700	7,949

Source: US Bureau of Census enumeration, 1990

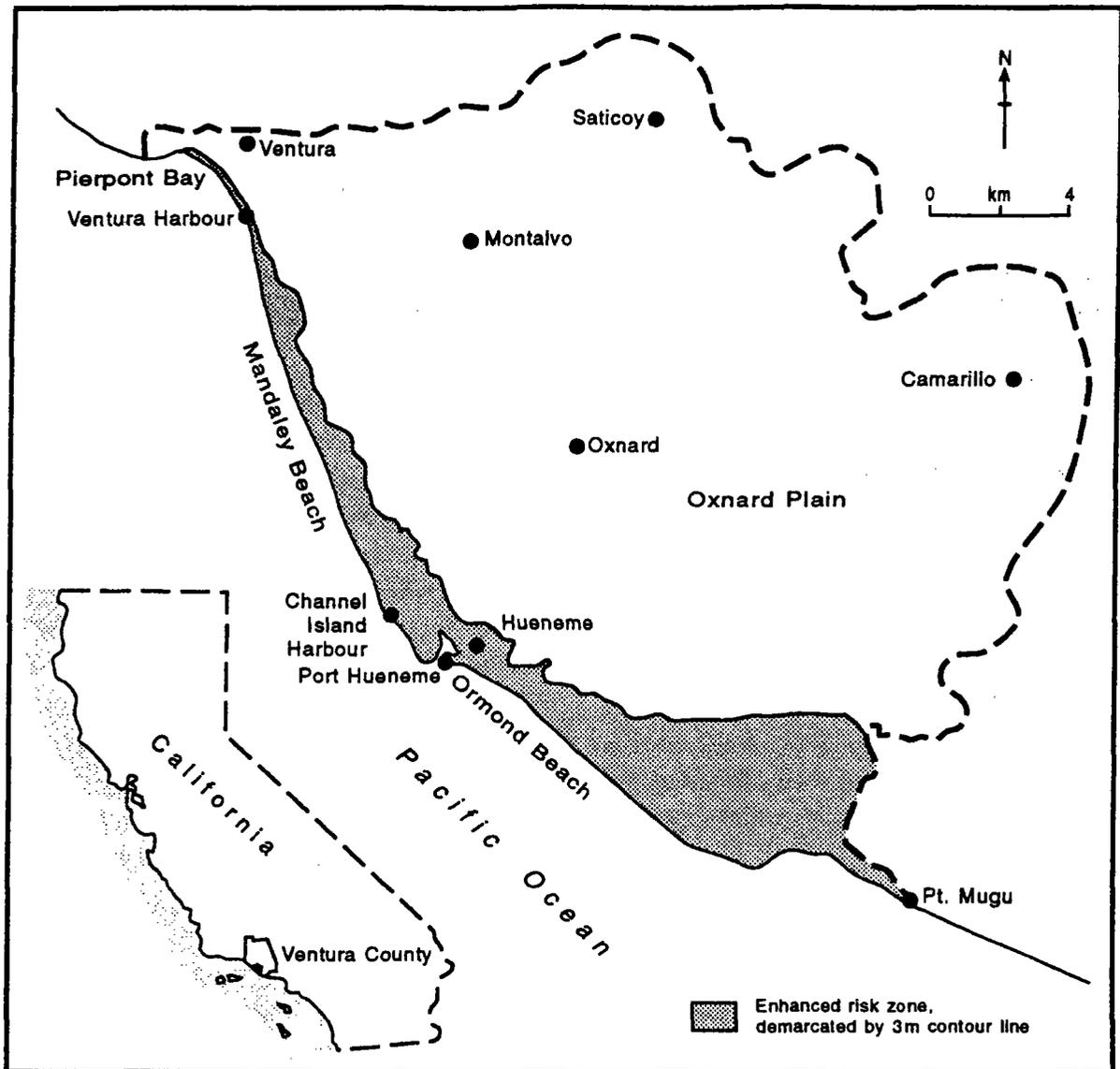


Fig. 5. Enhanced risk zone and Oxnard plain, Ventura County, California, 1994.

The 1990 census enumerated population of Ventura County was 669,000; 18 per cent or 122,248 persons resided in coastal census tracts, and 48 per cent or 326,900 lived within the approximated boundaries of the Oxnard Plain. Of the plain residents, more than 40,100 (13 per cent) dwelled on land estimated as 3m or less above sea level, the area most likely to experience the earliest impacts from sea level rise.

The State of California Department of Finance projections suggest that Ventura County population could reach 1,319,000 persons by 2040 doubling the 1990 population. Population increased 41 per cent during the 1970s or by 152,877 persons. The coastal tracts increased by 27,500, and the Oxnard Plain by almost 71,600. During the 1980s, county population increased 27 per cent or 141,600, and the coastal census tracts by 24,000, while 61,000 persons were added to the Oxnard Plain.

While the coastal tract residents are presently experiencing problems due to chronic beach erosion and periodic storm surges, real estate development continues at a rapid rate. Mounting insurance company concerns could lead to discontinuance of coverage in high risk zones, thus further limiting land resources and development and reducing available government tax sources (Berz, 1991).

## **8. Organizational Responses**

Population impacts of rising sea level in California will be influenced and mitigated by the "social construction" of the hazards, legislation, responses to legislation, actions by relevant government agencies, and the monitoring of regulatory enforcement by "stakeholders" with sometimes opposing interests.<sup>7</sup> These stakeholder groups and their positions are assumed to be as follows:

- (1) Groups favoring population and development in coastal and delta zones -- business organizations, real estate associations, developers, contractors, fishing interests, and elected officials of some coastal communities.
- (2) Groups advocating concentration of commercial and housing development in more central, urban areas -- elected and appointed officials in central city coastal and delta area and their constituencies.
- (3) Groups opposed to rapid coastal and delta population growth and to development of the open space of those areas and encouraging low-density housing in the enhanced risk zone -- private sector insurance companies, environmental and neighborhood organizations, farmers affiliations and governmental agencies involved in environmental protection and management.
- (4) Groups desiring greenbelts and open spaces for parks particularly in enhanced risk zones -- local, national and international environmental and neighborhood organizations, parks and recreation departments (Koss and Van Arsdol, 1981).

Policy alternatives for distributing growth among regions of the state are limited. First, much of the area of inland counties consists of federal land -- legal mandates and public sentiment tend to reserve these lands for uses that are incompatible with urban development. Second, most private non-urban land in inland counties is devoted to agriculture. Third, many residents of sparsely settled inland areas support local growth limitation ordinances (Koss, Van Arsdol and, Mongeau, 1987). Tax incentives and disincentives may also play a role in population distribution. Local governments--

counties and cities--have at their disposal population growth and distribution control measures but local growth limitation has several negative economic and social consequences, including rising housing prices, increases in homelessness, a contracting economy and increased ethnic segregation (Koss, Van Arsdol and Mongeau, 1987). Enactment and implementation of the policies necessary to distribute and manage population change depends on convincing various "stakeholders" that their interests and the welfare of the community in general will be served by land use policies.

## **9. Conclusions**

Global warming may affect sea level resulting in coastal population impacts. We describe population and social impacts of sea level rise in California. Local sea level rise is expected to decrease the base of California's coastal zone land available for settlement. Coastal population is increasing, and an increasing area is at risk for erosion and flooding.

Rapid population growth is projected for California's coastal counties which now contain nine-tenths of the state's population. For coastal areas in general (excluding the north coast), large population growth is expected. Population increases in California's coastal neighborhoods will exacerbate the instability of the coastline ecology. Population growth in coastal neighborhoods of coastal counties from 1970 to 1990 were not as rapid as in inland neighborhoods of these counties, perhaps reflecting increasing land scarcity and costs. Nevertheless, population increases are likely to stimulate more intense development of coastal lands, and result in the urbanization of much of the California coast. Property loss and population displacement resulting from any sea level rise could be high. In contrast to most past victims of environmental degradation and disasters, future "environmental refugees" from the California coast may be less economically disadvantaged.

Population growth impacts global land use (Jolly and Torrey, 1994). Rising coastal land values may eventually limit degradation, but there also appear to be limits in the ability of the coastal environment to support populations. Population phenomena can be regarded as proximate causes of coastal environmental degradation, but not always the most important cause. The nature of population-degradation relationships appears to depend on the level of aggregation of questions and data, disciplinary perspectives, and time frames (Heilig, 1993; Keyfitz, 1993). As our research continues we will attempt to resolve some of these issues.

## Footnotes

<sup>1</sup>Support is from the U.S. National Oceanic and Atmospheric Administration (NOAA) grant #NGA36GPO486. The views expressed are the authors and do not represent those of NOAA.

<sup>2</sup>California coastal counties, listed in Figure 1 are as specified in NOAA (n.d.i.a). The 672 coastal counties in the United States (285 on the Atlantic, 142 on the Gulf of Mexico, 87 on the Pacific, and 158 on the Great Lakes) accounted for almost 54 per cent of the Nation's population and 25 per cent of the land area including Alaska in 1990. Excluding Alaska, the proportion of the US land area classified as coastal decreases to 17 per cent. Coastal counties had at least 15 per cent of their land area in the nation's coastal watershed, or, for counties that bisected the coastal watershed, had less than 15 per cent of their total land area in the coastal watershed and accounted for at least 15 per cent of a coastal cataloguing unit. Also see US Bureau of the Census (1991) and NOAA (n.d.i.b).

<sup>3</sup>The projections use a baseline cohort component method, assume a convergence of county race/ethnic-specific fertility rates, and projected increases in life expectancies for race/gender groups, consistent with U.S. Census Bureau expectations. Migration is expected to decline from 1990 to 1995 due to the current economic recession in California, but to increase thereafter and decline again after 2010.

<sup>4</sup>We excluded the 8 inland counties classified as coastal by NOAA, plus Napa county which has no coastal census tracts.

<sup>5</sup>Population in the coastal census tracts in the 20 coastal counties was 1,259,243 and 1,657,025 in 1970 and 1990 respectively. Housing units were 463,307 and 714,807. Population in the non-coastal tracts was 14,981,243 and 21,094,559 in 1970 and 1990, respectively, housing units were 5,218,890 and 7,772,179.

<sup>6</sup>The Ventura Marina (Griggs, 1985:295) was nearly destroyed in a 1969 flood and remains vulnerable to seasonal storms, shoaling and potential sea level rise. The Oxnard Plain contains costly waterfront property with a 1990 average value for the 110,000 housing units of the coastal census tracts of \$259,880. This compares with an average housing unit value of \$247,983 for the 188,300 housing units in the non-coastal tracts of Ventura County.

<sup>7</sup>We are indebted to Margo Koss for the use of the "stakeholders" concept.

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