Role of Water Supply and Sanitation for Hill Area Development Using Remote Sensing and GIS Techniques: A Case Study of Shillong Urban Agglomeration, India

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Paper presented to the PRIPODE workshop on

Urban Population, Development and Environment Dynamics in Developing Countries

Jointly organized by CICRED, PERN and CIESIN

With support from the APHRC, Nairobi

11-13 June 2007

Nairobi, Kenya

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Abstract

People's lives and livelihoods depend on water. Demand for clean water increases continually in line with world population growth. People in many areas of the world lack fresh, drinkable water essential to their survival. Unchecked population growth and the changing demographic profiles are affecting management of water resources in the towns and cities since the beginning of the twentieth century. At the turn of twentieth century only one percent of the population lived in the cities in most regions of the world. But as the urban population of the world has increased phenomenally during the century, so has the proportion that lived in the urban areas.

Access to water is a fundamental need and constitutes one of the most important human rights. But most cities in the developing world and in hilly and mountainous regions suffer from acute shortage of water both in quantity and quality. Water supply and sanitation are two most important factors for development of any urban centre especially in the context of hill area development and in the context of rapid growth of urban population. Shillong is one of the most important urban centres in the hilly regions of North-Eastern India. Geographically, it is located in the Meghalaya plateau which at least surfacially is an extension of North-Eastern Himalayan range and only 55 km away from Mawsynram, the highest rainfall station in the world. Shillong is a small (25.4 square km) capital town of Meghalaya, supporting 26, 7662 people (Census, 2001) and with a density of 10538 persons per square kilometre. However, the city has witnessed unprecedented population growth in recent years largely due to a high fertility rate coupled with a heightened migration from the neighbouring states of India as well as across the border. The city has been attracting migrants since colonial times mainly for its congenial climate, better school infrastructure, jobs and tourist spots.

The present paper aims at getting an insight into the effects of rapid growth of urban population on water supply situation with a particular emphasis on spatial aspects of hill area development since 1901. The paper examines changing demand for water and the sanitation system in the context of rapid growth of urban population in the city. The water supply in the town is mainly controlled by the SMB (Shillong Municipality Board) through PHE (Public Health Engineering) and *Durbar* (Local Community). There has been an unprecedented increase in demand for water (drinking and other domestic purposes) and in comparison; the supply is very low in the urban agglomeration. In a large number of cases, the people are left with no other option but to make their own arrangements to meet their water requirements either by sending household members to the sources for collecting water or by hiring the services of private suppliers, who collect water from different springs and supply them by *tins* and tanks with very high price. The main sources of water in the city are controlled by only 9 main natural springs. Most of the springs are unprotected. The situation worsens in the dry months when the springs too dry up.

The problem of water supply has been investigated with the help of a household survey. Over 30% of the households were selected by random sampling

technique from each *durbar* as well as wards during the year 2005. Using remotely sensed data (Aerial Photograph) all households' structure (Residential and Institutional), location of springs, roads, rivers, pipelines etc were identified in the GIS platform (Arc GIS) and the surveyed data were profitably linked using GPS (Global Positioning System) for the study. A detail analysis was made based on sources of water, distance from the household, quality, quantity, demand, supply and cost of expenditure in the households, both for the residential as well as for the institution population. The study also investigated sanitation.

The findings of the study revealed glaring facts about the water supply and sanitation in this town. Over 80% households in Shillong received water supply from the SMB, PHE and Durbar while 19 % got it from the public sector. Over 50% households who used water from the SMB water reported insufficient supply of water. Interestingly over 60% households using water from the private sources were not even aware of the source of the water. Less than 30 % of the households received sufficient or adequate water from the municipality sources leaving a great majority of the population with little and grossly inadequate water. The disparity in mere availability of water was found to be phenomenal. Nearly 69 percent of the households having sufficient water from the municipality source (SMB and PHE) have access to safe or treated water from the sources. About 14 % of the households do not use treated water from the sources. Only 54.2 % households have access to piped drinking water facility. The proportion with access to treated drinking water through pipes to the household increases with increasing income. Only 30 % of households in the lowest income quartile have access to safe drinking water sources compared to 62% in the highest income quintile.

The implications of these findings need to be viewed seriously by policy makers. If people are to prosper, more secure and low cost water supplies are needed. The paper makes an attempt to provide policy guidelines in this direction.

Generalities:

Water is essential for life. Water is also a necessity for drinking, for producing food, for washing and is essential for maintaining health and dignity. Water is required for both domestic and non domestic use like in schools, colleges, institutions, offices, markets etc. The integral role of water in international development has been recognised over the last two decades, with several international agreements specifying targets on water supply and sanitation dating back to the United Nations Children fund's (UNICEF) 1980 International water supply and Sanitation Decade (IWSSD), which established the target of universal coverage of safe water supply and sanitation by 1990. While significance numbers of people gained access to improved drinking water supply and better sanitation over the decade, the target was not met due toa number of constraints, the most important being unchecked population growth in certain parts of the globe. It was, however, re-adopted as a target for the year 2000 at the World Summit for Children in 1090. More recently targets have been established by the Water Supply and Sanitation Collaborative Council (WSSCC) as part of the progress leading up to the Second Water forum in The Hague in March 2000. The target presented included: to reduce by 2015 by one half of the proportion of people without access to hygienic sanitation facilities and to reduce by 2015 one half of the proportion of people without sustainable access to adequate quantities of affordable and safe water, which was also endorsed by the United Millennium Declaration. The target also included a resolution to provide water, Sanitation and hygiene for all by

2025[1]. It is a matter of grave concern that lack of drinking water and sanitation kills about 4500 children a day and sentences their siblings, parent and neighbours to sickness, squalor and enduring poverty. Needless to emphasise, improvement in quality and quantity of water brings immediate and lasting benefits in health, dignity, education, productivity and income generation[2].

Changes Affecting Water

It is important to set the issues surrounding water in a global context. The world is changing at an ever increasing rate. Many of these changes are having an impact on how we, as humans, utilize the world's water. Rapid growth of the World's population has been one of the most visible and dramatic changes to the world over the last hundred years. Population growth has huge implications for all aspects of resource use, including water. Although water is a renewable resource, it is only renewable within limits; the extent to which increasing demands can be met is finite.

People's lives and livelihoods depend on water. Demand for clean water increases continually in line with world population growth. People in many areas of the world lack fresh, drinkable water essential to their survival. Unchecked population growth and the changing demographic profiles are affecting management of water resources in the towns and cities since the beginning of the twentieth century. At the turn of the twentieth century only one per cent of the population lived in the cities in most regions of the world. But as the urban population of the world has increased phenomenally during the century, so has the proportion that lived in the urban areas.

As population increases, freshwater demand increases and supply per person inevitably decline[3]. In addition to general population growth, the changing demographics are affecting how water resources are managed. At the beginning of the twentieth century, only a small percentage of the population lived in cities in most regions of the world, but as the world population has increased, so has the proportion that lives in urban areas. The urban population increased rapidly throughout the twentieth century and is projected to reach 58 percent of the world population by 2025 ((UNFPA, 2002). In the next thirty years, the greatest urban growth will occur in Asia. UN (2002) estimates show that in real terms the urban population of the less developed world is expected to nearly double in size between 2000 and 2030 i.e. from a little under 2 billion to nearly 4 billion people. Between 2015 and 2020, urban population will exceed the rural population for the first time, and will continue to escalate sharply rural numbers remaining more or less static.

Access to water is a fundamental need and constitutes one of the most important human rights. But most cities in the developing world and in hilly and mountainous regions suffer from acute shortage of water both in quantity and quality. Water supply and sanitation are two most important factors for development of any urban centre especially in the context of hill area development and in the context of rapid growth of urban population. Shillong is one of the most important urban centres in the hilly regions of North-Eastern India. Geographically, it is located in the Meghalaya plateau which surfacially is an extension of North-Eastern Himalayan range and only 55 km away from Mawsynram, the highest rainfall station in the world. Shillong is a small (25.4 square km) capital town of Meghalaya, supporting 26, 7662 people (Census, 2001) and with a density of 10538 persons per square kilometre. However, the city has witnessed unprecedented population growth in

[1]. Source: WSSCC, 2000.
[2]. Water for Life, Making it Happen, WHO, UNICEF, 2005, P.5.
[3]. Gardner-Outlaw and Engelman, 1997.

recent years largely due to a high fertility rate coupled with a heightened migration from the neighbouring states of India as well as across the border. The city has been attracting migrants since colonial times mainly for its congenial climate, better school infrastructure, jobs and tourist spots. The location of the town in a hilly region, continued increase in urban density, increased migration to the city are some of the many factors which have aggravated the already acute problems of water shortage in the city. The city thus makes for an excellent case study for the present research.

The main aim of the present research is to get an insight into the effects of rapid growth of urban population on water supply situation with a particular emphasis on spatial aspects of hill area development. The paper examines changing demand for water and the sanitation system in the context of rapid growth of urban population in the city. The water supply in the town is mainly controlled by the SMB (Shillong Municipality Board) through PHE (Public Health Engineering) and *Durbar* (Local Community Organisation). There has been an unprecedented increase in demand for water (drinking and washing) and in comparison; the supply is extremely inadequate in the urban agglomeration. In a large number of cases, and particularly in the dry months extending over 6 months in a year the people are left with no other option but to make their own arrangements to meet their water requirements either by sending household members to the sources of water often located in far off distances for collecting water or by hiring the services of commercial suppliers, who collect water from different springs and supply them by *tins* and tanks at a very high price. The main sources of water in the city are controlled by only 9 main natural springs i.e. Phud Umshing River, Wah Umiam River, Wah Umro, Wah Umkrah, Nongrimbah Stream, Phud Raimut, Umshyrpi, Um Phyrnai and Wah Demthring.

Most of the springs are however unprotected. The situation worsens in the dry months when the springs dry up too.

Data and Methodology

Much of the data required for this research is obtained from both primary and secondary sources particularly those published by successive census enumeration. Census publications pertaining to urban population data are used to analyse patterns in the distribution and growth of population at ward level.

The methodology proposed to be adopted for the present research is outlined below:

As has been mentioned earlier, the main objective of the research is to assess the extent growth of urban population and consequent increase in demand of water.

Using remotely sensed data (Aerial Photograph) all households' structure (Residential and Institutional), location of springs, roads, rivers etc have been identified in the GIS platform (Arc GIS) and the surveyed data were profitably linked using GPS (Global Positioning System) for the study.

The problem of water supply and sanitation has been investigated with the help of a household survey. A household survey of 30 percent of the households are chosen on a random basis from each ward as well as towns to elicit information on the primary and secondary sources of water, supply and uses of water, availability of water, frequency and demand and supply of water with households income for both domestic as well as non domestic users like school, college, offices, hotels, shops, restaurants etc in present days and other related problems liked to water and sanitation problem.

A detail analysis was made based on sources of water, quality, quantity, demand, supply and cost of expenditure in the households, both for the residential as

well as for the institution population. The study also investigated the problems of sanitation.

Findings

The density of population in Shillong has been increasing phenomenally over the years. The 2001 Census recorded a population density of 10500 inhabitants per square kilometer as against 8794 inhabitants per square kilometer only a decade before. Table-1 reveals the trend in population growth since the beginning of the 20th century. As is evident from the table, the city experienced fluctuating trend in population growth throughout the period under review. Rate of population growth has been extraordinary during 1941-61 decades. However, it may be noted that the density of population has been registering a continuous rise over the entire period. From a meager 379 persons per square kilometer at the turn of the 20th century, the city now supports as many as 10, 538 persons per square kilometer by the turn of 21st century- in a span of a century.

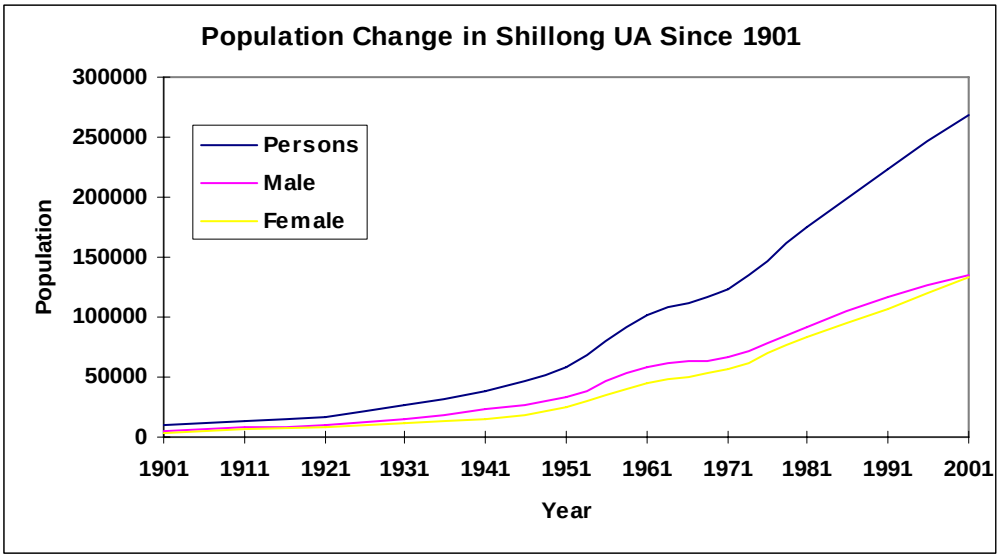


Fig: 1

Table-2 presents a synoptic view of the rate of population growth as it varies between different townships in Shillong urban agglomeration and by different ethnic categories during the year 1991-2001. As is evident from the table, the rate of growth varies substantially across different localities. The scheduled tribe population compared to other categories has experienced much higher rate of increase in population. As many as three localities have registered far greater increase in population.

Adequate quantities of safe water for consumption and its use are complementary measures to promote hygiene and for protecting health in the hilly area. Households which have safe drinking water facilities reduce to risk of transmission of water borne diseases compared to other households that do not have access to safe drinking water. Quality of drinking water that people use in Shillong however depends upon easy access. Analysis of water use in the city revealed that if safe drinking water is accessible to a household, people use large quantities for hygiene, but consumption drops significantly when water must be carried from distant places. Table-3 provides valuable information on access to improved drinking water facilities. More than half of the households in Shillong Urban Agglomeration have drinking water piped to their houses and more than one fourth of the households have

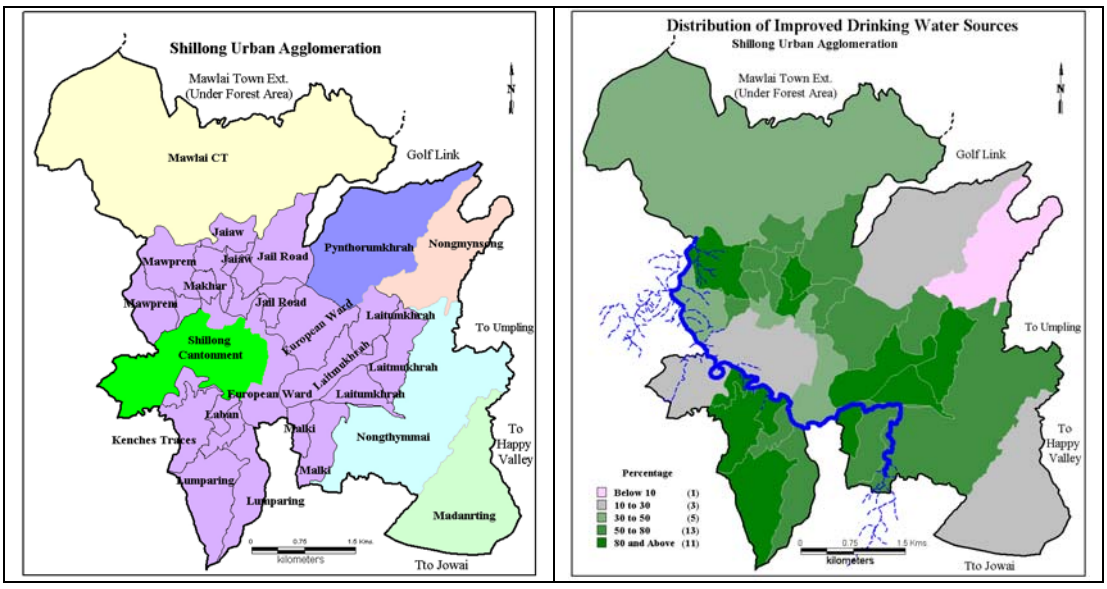
access to other sources of drinking water. 86 per cent of the households have access to either safe and improved clean drinking water sources. It is significant to note that over14 per cent households do not have any access to improved drinking water sources.

Town Level Pattern

This overall pattern however conceals extreme variation that is found when the data is scrutinised at lower spatial units, i.e. different towns/wards that constitute the agglomeration. Of the seven towns that constitute the agglomeration, Shillong Municipality is relatively better placed in terms of improved access to safe drinking water i.e. piped water through house connection or yard. 72 per cent of the households enjoy the facility of piped water supply into their households compared to none in Nongmynsong or only 18 percent in Madanrting town. Nongthymmai has 66 percent households with an access to piped water supply.

Over three fourths of the households in Shillong Cantonment (CB) and over half of the households in Mawlai (CT), Pynthorumkhrah (CT) and almost half in Madanrting (CT) have access to other sources of improved drinking water i.e Public standpipe, Protected tube well or bore well, protected drug well or protected spring, rain water etc. Nongmynsong (CT) is at a great disadvantage in terms of access to other improved drinking water sources too. Nongmynsong (CT) is the worst in terms of improved drinking water as over 93 per cent households having little access to any improved drinking water sources.

Table-4 reveals extreme inequity in the availability of safe drinking water across the wards distributed over the agglomeration. It is surprising that around 50-80 per cent of the households in police Bazar and over 80 per cent households in Nongmynsong have no access to safe improved drinking water facility. Around 30-50 per cent households in Madanrting too do not have access to safe improved drinking water. Areas like Mawlai, Pynthorumkhrah, Shillong Cantonment have 50-80 per cent households who depend on other than piped water supply for drinking purposes.



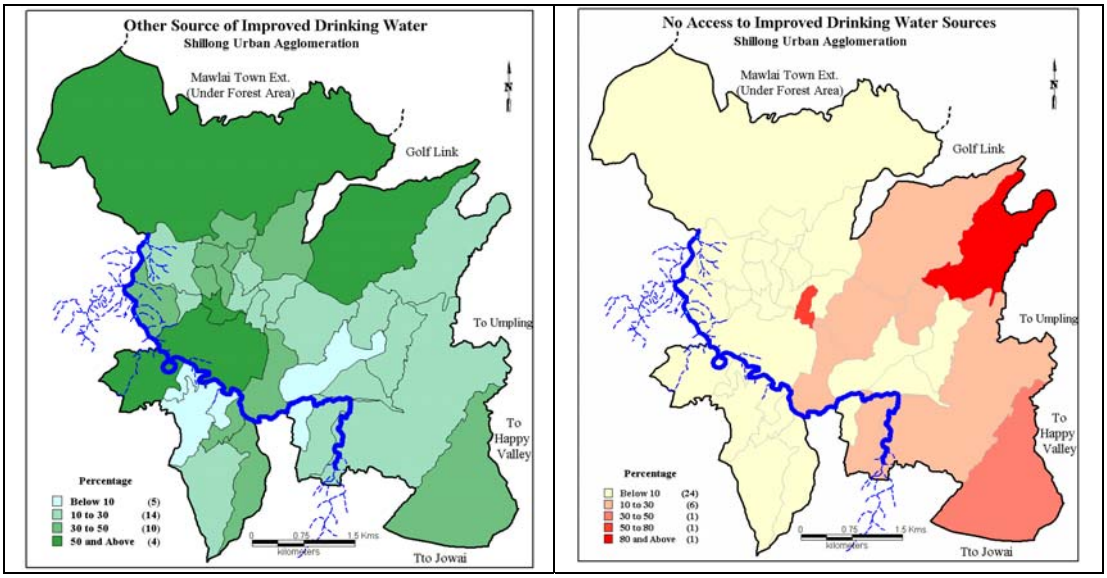


Fig: 2

Income level appears to be an important determinant to access to safe drinking water in the city. Table-5 amply demonstrates the fact that higher household income is positively associated with increased access to safe drinking water. Going by the two sources of safe drinking water facility, larger income is associated with greater access to improved water with a corresponding decline in access to other sources of improved drinking water. However, over 12 per cent of the households in the higher income bracket do not have access to any source of improved drinking water-a fact that defies easy explanation. It may however be easily deduced that access to safe drinking water is largely a private endeavour indicating failure of public distribution system and that there are extreme difficulties of physical availability of water that even prevents some rich households to gain access to safe drinking water. Locational factors largely explain the failure of some of the relatively rich sections' inability to gain such an access. Localities such as Madanriting and Nongmynsong which have difficult physiographic conditions in relation to water availability are examples of this kind where a majority of the rich too finds it difficult to obtain safe drinking water either from piped water supply or through other means (Table-6).

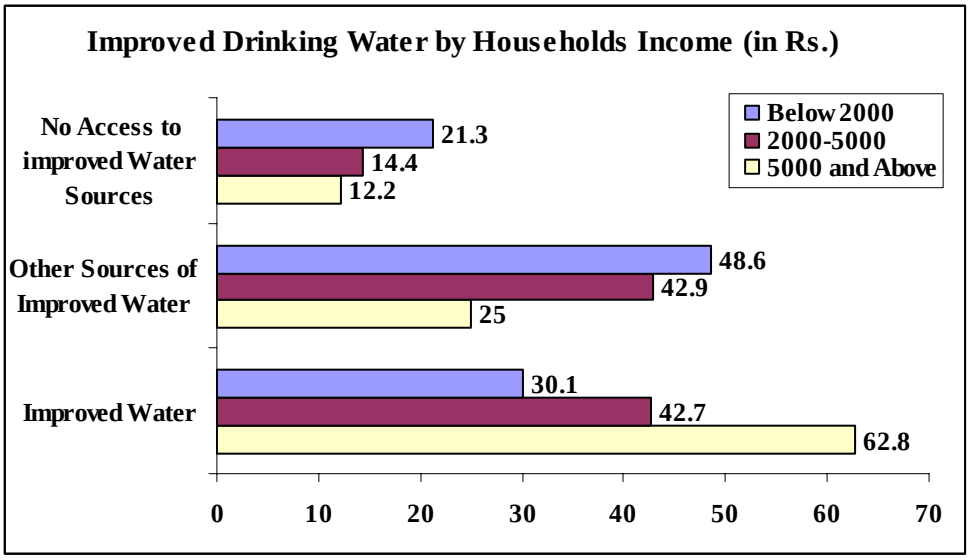


Fig: 3

Table-7 shows that a little over 8 per cent of water available from all sources is used for drinking/cooking or washing. Over 90 per cent of the available water is used for other purposes in Shillong. A greater proportion of the water obtained from private suppliers is used for drinking, cooking and washing. It is interesting to note (Table-8) that a greater proportion of the available water from primary sources is used for cooking, drinking and washing as the income level goes up. Increase of water use for washing increases phenomenally as the income level of the household increases. This is largely due the use of washing machines as well as washing at home. The poorer sections however resort to community washing at common places using spring water, a sight very common within the city.

Sources of Water

The city dwellers are dependent on two main sources of water, viz. Primary as well as secondary. The SMB and the PHE supply water to nearly 68 per cent city inhabitants, while the local Durbar, a community level organization takes care of 12.7 per cent city dwellers for their water requirement from primary sources. Private suppliers too take care of 4.7 per cent of all households using primary source of water supply. There is a great multiplicity of sources and supply system as far as water supply to Shillong residents are concerned (Tables 9 and 10). Fewer households use secondary sources for the water supply. The private suppliers mainly use secondary sources of water for supplying to the residents in areas of water crisis or in times of water shortages in other areas.

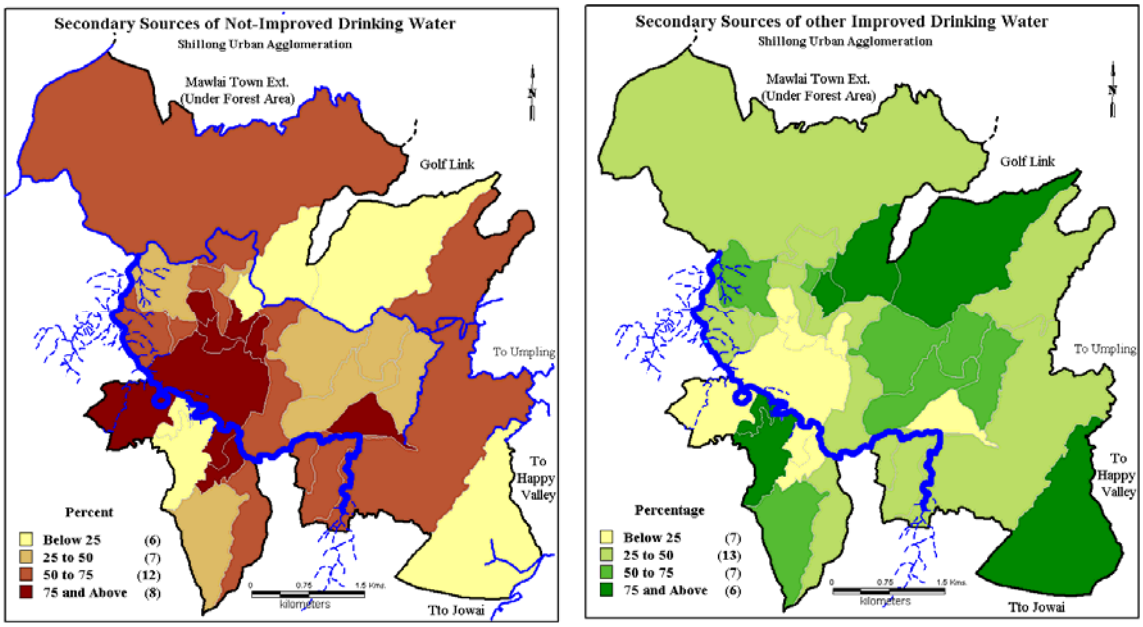


Fig: 4

It is evident from the table-12 that a significant proportion of the households have to budget some part of their monthly income on purchasing water. Even the poorer households with a monthly income of less than Rs. 2000 too have to buy water from private suppliers. Around a quarter of all poor households buy water, while the proportion of such households in the upper income group is more at a little over 47 per cent. It is even more significant that around 7 per cent of the poorer households have to spend as high as Rs. 500 and more of their monthly income on purchase of water alone. Needless to say that poverty is accentuated in Shillong by the factor of unavailability of water to large sections through public distribution system.

The extent of expenditure on water in different areas of Shillong however is not uniform. Residents in some areas have to bear the burden more than the others revealing that location is an important factor in determining the expenditure level for water. Table-13 shows that a great majority of residents in Madanriting, and Nongthymmai do have to spend a very high proportion of their monthly income on water. Around a quarter of the residents in the former and over 15 per cent residents in the latter spend more than Rs. 500 of their monthly income on water alone. Relatively less proportion of the households residing in Pynthorumkhrah and Shillong Municipality spends large amount on water. The most significant aspect of water situation in Shillong relates to a situation of crisis that affects the entire city though the degree varies from locality to locality. Table-14 reveals that a lot of time is spent by the residents in collecting water from different distances as in many cases piped water supply is not available within the house. An hour to more than two hours of time is invested by over 30 per cent residents just for collecting water.

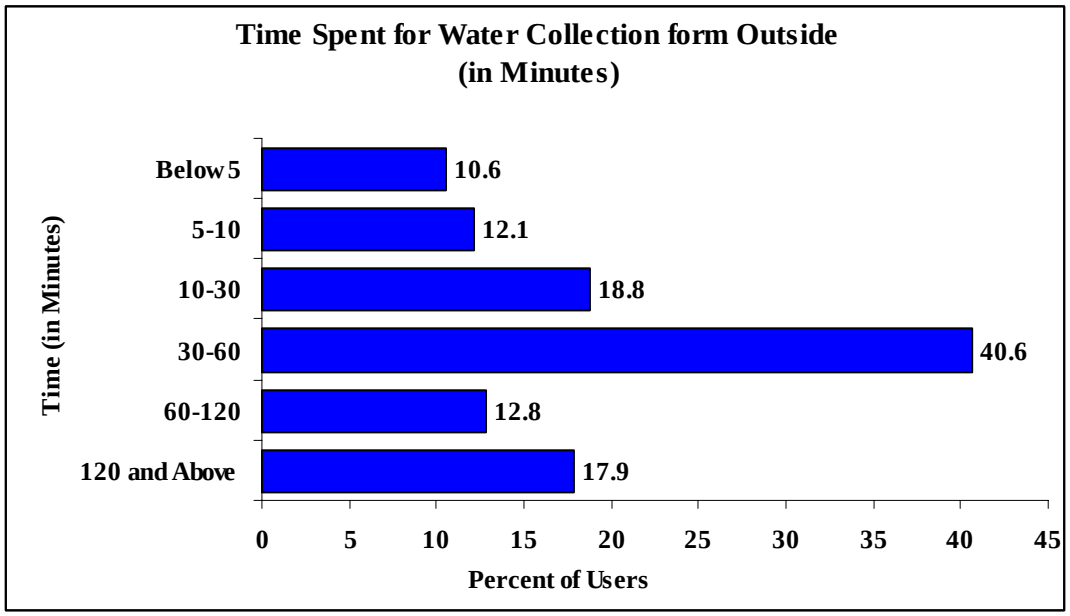


Fig: 5

Sanitation

Sanitation facilities too pay a crucial role in health, personal hygiene and the spread of communicable diseases across a population. Epidemiological evidence suggests that sanitation is at least as effective in preventing disease as in the case of improved water supply (WHO, 2003[4]). The Millennium Development Goals aim at achieving a significant improvement in the lives of at least 100 million slum dwellers by 2020. The percentage of urban population with access to improved sanitation is one of the indicators used to measure progress towards this goal (WHO and UNICEF, 2000).

The sanitation survey conducted in Shillong provides data on the proportion of households with access to a flush toilet to sewage system (a high technology where sanitation does not take place onsite but municipality and thereby minimizes the risk of contamination with excreta), the population with access to improved sanitation facilities, and the population without access to improved sanitation.

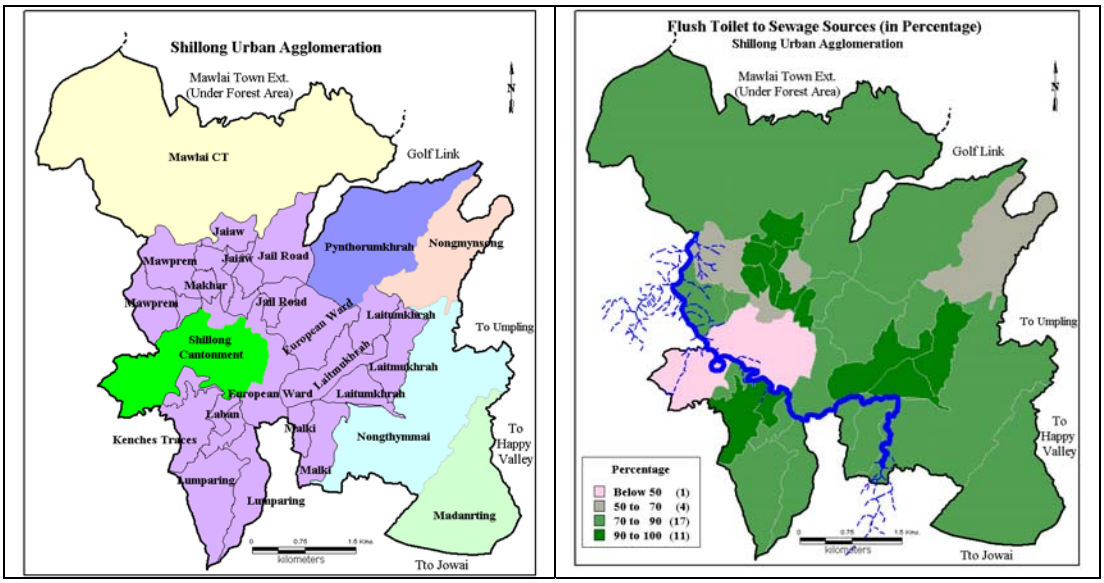
Table-15 shows that 65 per cent of the households have access to private toilet facility whereas over 33 per cent uses shared or community toilets and about 2 per

[4] WHO Manual, 2003: World Health Survey-Data Analysis and Report Writing Guidelines, Geneva.

cent households have no access to toilet facility. Among the towns of Shillong Cantonment area shows the worst condition in terms of toilet facility. Over 17 per cent households do not have any mode of toilet facility. Shared or community toilets are used by a majority of residents in Nongmynsong and Shillong Cantonment areas while close to half the population in Pynthorumkhrah too uses shared or community toilets. A very large proportion of the population has access to private toilets only in Nongthymmai. In the urban agglomeration as a whole nearly a third of all households has to depend on community or shared toilets.

Table-16 provides the data on access to improved sanitation facilities in seven towns for Shillong Urban Agglomeration. Good sanitation facilities refer to those technologies that are likely to provide adequate sanitation; foe example, hygienically separate human excreta from human contact.

Overall, 82 percent of households in Shillong have access to flush toilet with sewage system compared to Urban India's record of only 23 per cent. The proportion of households having other improved toilet facilities is only 9 percent and over 9 percent of households have no access to improved sanitation. It means nearly one out of every ten households is still deprived of access to improved sanitation facilities. The inequalities are highly prominent among the towns. Access to improved sanitation as measured by toilet facility and its types reveals wide variation as the data is scrutinized at lower spatial level i.e for different wards included in the towns of the urban agglomeration. As many as 6 out of 33 wards have over 20 percent households without access to improved sanitation facility (table-17).



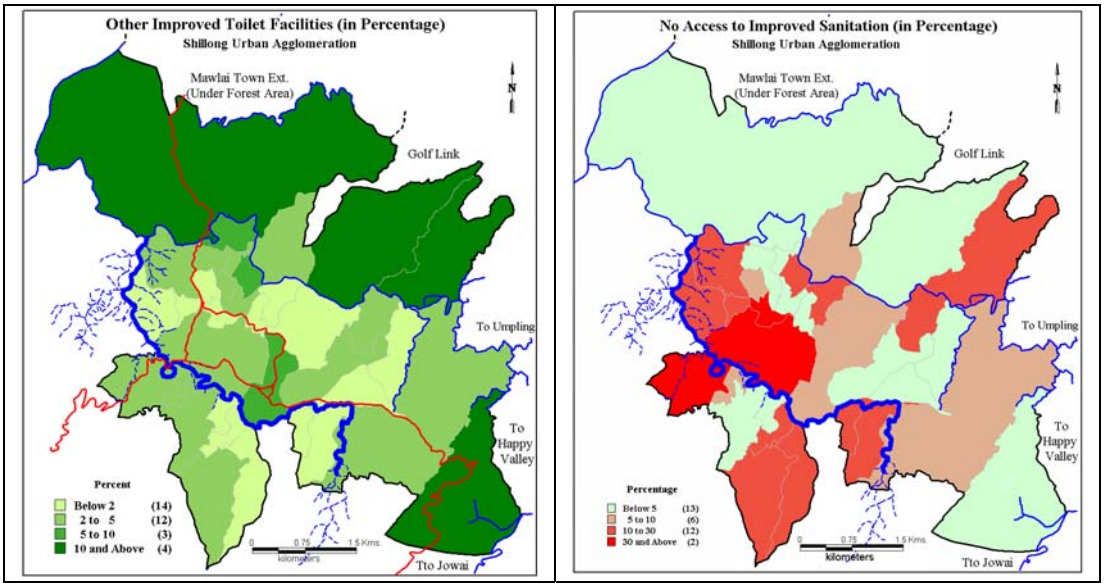


Fig: 6

Conclusion

The overall picture that emerges from the study is that the city needs a better water management system to meet growing demands for water both in terms of quantity and quality. Public distribution system of water is not only inadequate but also inefficient to such an extent that a very large section of the people have to fend for themselves to meet their water requirement at great costs both financially and in terms of time. Locational factors emerge as a great constraining factor-a fact common to many hilly and mountainous terrain. Efforts are needed for a more realistic urban planning keeping in mind availability of water in deciding expansion of the city for residential purposes. A good urban landuse map is an urgent need which should provide guidelines for future development of the city based on the factor of water availability. The situation calls for a more scientific understanding of the geological setting of the urban area and its hinterland identifying potential areas for tapping of water resources. The current expansion of the agglomeration seems to have taken no notice of these factors and hence may create even worse conditions of water shortage which even better water management may not be able to ameliorate. Situation with regard to sanitation however is satisfactory barring a few areas. The implications of these findings need to be viewed seriously by policy makers. If people are to prosper, more secure and low cost water supplies are needed.

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TABLES

Table: 1

Growth and Density of Population Since 1901

Year	Population			Growth (in Percentage)/year			Density/ sq. Km
	Persons	Male	Female	Persons	Male	Female	
1901	9621	5577	4044	-	-	-	379
1911	13639	7762	5877	4.2	3.9	4.5	537
1921	17203	9512	7691	2.6	2.3	3.1	677
1931	26536	15634	10902	5.4	6.4	4.2	1045
1941	38192	22696	15496	4.4	4.5	4.2	1504
1951	58512	32790	25722	5.3	4.4	6.6	2304
1961	102398	58082	44316	7.5	7.7	7.2	4031
1971	122752	66161	56591	2.0	1.4	2.8	4833
1981	174703	91728	82975	4.2	3.9	4.7	6878
1991	223366	117373	105993	2.8	2.8	2.8	8794
2001	267662	134497	133165	2.0	1.5	2.6	10538

Source: Census of India, 1991 & 2001

Table: 2

Shillong Urban Agglomeration: Population Growth (Rate in %) / Year (1991-2001)

NAME	Total Population	0-6 Years Population	Scheduled Caste Population	Scheduled Tribe Population	Scheduled Population	Non Scheduled Population
Shillong (M)	0.1	-2.2	-5.5	0.9	0.7	-0.5
Mawlai (CT)	2.4	0.1	163.3	2.6	2.6	-1.0
Nongthymmai (CT)	2.7	-0.2	17.5	3.9	3.9	0.9
Pynthorumkhrah (CT)	6.2	3.3	6.8	11.9	11.8	2.7
Shillong Cantt. (CB)	1.2	0.4	0.7	2.8	1.8	1.1
Madanrting (CT)	8.2	4.6	24.3	8.5	8.6	7.5
Nongmynsong (CT)	8.7	5.7	143.3	13.1	13.3	6.6
Shillong UA	**2.0**	**-0.2**	**-3.5**	**2.9**	**2.8**	**1.0**

Table: 3

Percentage Distribution of Households with Access to Improve Drinking Water Sources

Name of the Town	Improved Drinking Water[1]	Other Sources of Improved Drinking Water[2]	No Access to Improved Drinking Water Sources[3]	Total Respondents
Shillong (M)	72.0	22.7	5.3	1698
Mawlai (CT)	33.7	57.1	9.2	463
Nongthymmai (CT)	66.0	18.6	15.4	483
Pynthorumkhrah (CT)	27.7	56.5	15.8	300
Shillong Cantt. (CB)	18.8	75.1	6.1	64
Madanrting (CT)	18.3	48.8	32.9	218
Nongmynsong (CT)	0.0	6.7	93.3	156
Shillong UA	54.2	32.1	13.7	3382
India (Urban)*	55.5	35.1	9.4	2728

Note:

1. Piped water through house connection or yard.

2. Public standpipe, Protected tube well or bore well, protected drug well or protected spring, rain water etc.

3. Unprotected drug well or spring, water taken directly stream, tanker-truck, vendor etc.

* *World Health Survey, 2003, India, WHO-India-WR Office, New Delhi, 2006, P-50.*

Table-4
Ward Level Drinking Water

% Households	Improved Drinking Water[1]	Other Sources of Improved Drinking Water[2]	No Access to Improved Drinking Water Sources[3]
Range	No. of Ward & Name	No. of Ward & Name	No. of Ward & Name
Below 10	(1) Nongmynsong		(24)
10-30	(3) Madanrting, Pythourmukhra, Shillong Cantonment		(5) Nongthymmai, Malki, Laithmkhrah, Pythourmukhra, European ward 2 W
30-50	(5) Mawprem, S. E. Mawkhar, Police Bazar, European Ward, Laban, Mawlai		(1) Madanrting
50-80	(13) Mawprem, Mawkhar, Jaiaw 3W, Jail Road 2W, European Ward, Laitumkhrah, Nongthymmai, Malki, Lumparing, Laban	Mawlai, Pynthorumkhrah, Shillong Cantonment, SE. Mawkhar	(1) Police Bazar
80 and Above	(11) Mawprem, Mawkhar 2W, Litumkhra 3W, Malki, Lumparing, Kenches Trace 2W, Laban	No Ward	(1) Nongmynsong,

Table: 5
Households with Access to Improved Drinking Water Sources by Income

Income (in Rs)	Improved Water	Other Sources of Improved Water	No Access to improved Water Sources
Below 2000	110 (30.1)	178 (48.6)	78 (21.3)
2000-5000	365 (42.7)	367 (42.9)	123 (14.4)
5000 and Above	1358 (62.8)	540 (25.0)	263 (12.2)
Total	1833 (54.2)	1085 (32.10	464 (13.7)

Table: 6
Households with Access to Improve Drinking Water Sources by Income in Town

Town		Access to Improved Drinking Water			
	Income	Improved Water	Other Sources of Improved Water	No Access to improved Water Sources	Total Respondent
Shillong Municipality	Below 2000	41.6	45.5	12.9	202
	2000-5000	64.0	30.7	5.3	417
	5000 and Above	80.8	15.4	3.8	1079
	Total	72.0	22.7	5.2	1698
Mawlai CT2	Below 2000	17.1	65.7	17.1	35
	2000-5000	21.4	68.8	9.7	154
	5000 and Above	42.7	50.7	6.6	274
	Total	33.7	57.9	8.4	463
Nongthymmai	Below 2000	37.0	22.2	40.7	27
	2000-5000	51.6	27.4	21.0	62
	5000 and Above	70.3	17.0	12.7	394
	Total	66.0	18.6	15.3	483
Pynthorumkhrah	Below 2000	13.2	56.6	30.2	53
	2000-5000	23.4	63.8	12.8	94
	5000 and Above	35.3	52.3	12.4	153
	Total	27.7	56.7	15.7	300
Shillong Cantonment	Below 2000	8.0	76.0	16.0	25
	2000-5000	20.0	80.0	0.0	30
	5000 and Above	44.4	55.6	0.0	9
	Total	18.8	75.0	6.3	64
Madanrting	Below 2000	8.3	58.3	33.3	12
	2000-5000	11.1	57.8	31.1	45
	5000 and Above	21.1	46.0	32.9	161
	Total	18.3	49.1	32.6	218
Nongmynsong	Below 2000	0.0	8.3	91.7	12
	2000-5000	0.0	11.3	88.7	53
	5000 and Above	0.0	9.9	90.1	91
	Total	0.0	10.3	89.7	156
Shillong UA	Below 2000	30.1	48.6	21.3	366
	2000-5000	42.7	42.9	14.4	855
	5000 and Above	62.8	25.0	12.2	2161
	Total	54.2	32.1	13.7	3382

Table: 7
Primary Sources of Water Supply by Uses (in %)

Sources of Water	Uses			
	All Uses	Only Drinking/Cooking	Washing	Total Respondent
SMB	94.8	3.8	1.4	1152 (34.1)
PHE	91.0	4.8	4.2	1164 (34.4)
Durbar	93.5	4.4	2.1	431 (12.7)
Pvt Suppliers	87.4	6.9	5.7	159 (4.7)
Other	85.3	7.1	7.6	289 (14.1)
Total	91.6	4.8	3.5	3382 (100)

Source: Field Survey, 2005

Table: 8
Primary Sources of Water Supply and Uses by Households Income

Income (in Rs.)	Absolute			Percentage			Total Respondent
	All Uses	Only Drinking/ Cooking	Washing	All Uses	Only Drinking/ Cooking	Washing	
Below 2000	332	30	4	10.6	17.9	4.4	366
2001-5000	783	50	22	25.1	29.8	24.4	855
5001 and Above	2009	88	64	64.3	52.4	71.1	2161
Total	3124	168	90	100	100	100	3382

Source: Field Survey, 2005

Table: 9
Primary Sources of Water and Supply System (in %)

Primary Sources	No of Household	Percent	Supply System (in Percent)
SMB	1152	34.1	SL-78.6, S-20.3,
PHE	1164	34.4	SL-58.9, S-40.5, T-.6
Durbar	431	12.7	SL-49.2, S-46.6, T-1.4, DW-2.8
Pvt Suppliers	159	4.7	P-90.6, T-9.4
Other	289	14.1	Sp-60.7, DW-30.0, PC-8, R-1.3
Total Respondent	3382	100	-

SL= Service Line, S=Stand Pipe, T= Tanker, PC= Private Carrier, Pani Walla and Tin RWH= Rain Water Harvesting, Sp= spring, DW= Deep Well, Tube Well or Bore Well.

Table: 10
Secondary Sources of Water and Supply System (in %)

Secondary Sources	No of Household	Percent	Supply System (in Percent)
SMB	99	2.9	PC-100
PHE	163	4.8	PC-100
Durbar	52	1.5	PC-100
Pvt Suppliers	552	16.3	PC-63, T-32
Other	1280	37.8	RWH- 42, Sp-23, DW-19, T-8 PC- 3.
Not Using	1236	36.5	-
Total Respondent	3382	100.0	-

SL= Service Line, S=Stand Pipe, T= Tanker, PC= Private Carrier, Pani Walla and Tin RWH= Rain Water Harvesting, Sp= spring, DW= Deep Well, Tube Well or Bore Well.

Table: 11
Supply of Water (in Liter) Per Day by Different Sources

	Absolute			Percentage		
Litres	SMB	PHE	Durbar	SMB	PHE	Durbar
Below 30	29	23	29	4.2	1.9	6.3
30-100	194	307	194	28.1	25.6	41.8
101-250	88	295	88	12.8	24.6	19.0
251-500	87	306	87	12.6	25.6	18.8
501-1000	41	213	41	5.9	17.8	8.8
Above 1001	251	53	25	36.4	4.4	5.4
Total	690	1197	464	100	100	100

Table12
Percentage Distribution of Monthly Households Expenditure for Water by Income Groups

	Monthly Income (in Rs.)			
Expenditure (Rs.)	Below 2000	2001-5000	5001 and Above	Total Respondent
None	76.8	70.6	52.7	2023
Below 50	7.9	9.5	19.4	529
50 to 100	2.5	2.5	3.9	114
100 to 250	3.8	5.0	7.8	225
250 to 500	2.2	6.7	5.6	187
500 and Above	6.8	5.7	10.6	304
Total	100.0	100.0	100.0	3382

Table 13
Percentage Distribution of Monthly Households Expenditure for Water by Town

Expenditure(in RS)	Shillong Municipality	Mawlai CT2	Nong-thymmai	Pynthor-umkhrah	Shillong Cantonment	Madanr-ting	Nongmyn-song	Shillong UA
None	63.0	80.1	29.2	87.7	53.1	22.0	61.5	59.8
Below 50	20.1	3.5	24.2	0.7	6.3	22.5	0.0	15.6
50 to 100	2.8	1.1	4.6	7.3	3.1	6.9	0.6	3.4
101 to 250	5.7	3.0	14.3	0.3	9.4	11.9	7.7	6.7
251 to 500	2.7	5.0	12.2	0.7	9.4	12.4	16.0	5.5
501 and Above	5.8	7.3	15.5	3.3	18.8	24.3	14.1	9.0
Total	100	100	100	100	100	100	100	100

Table: 14
Time spent for water Collection from Outside

Time (in Minutes)	Frequency	Percent
Below5	155	10.6
5-10	177	12.1
10-30	275	18.8
30-60	595	40.6
60-120	187	12.8
120 and Above	262	17.9
Total	1464	100.0

Table: 15
Shillong UA: Percentage Distribution of Sanitation Types

Town's Name	Private Toilet	Shared or Community Toilet	No Toilet Facility	Total Respondents
Shillong (M)	68.6	30.2	1.2	1698

Mawlai (CT)	55.5	43.4	1.1	463
Nongthymmai (CT)	85.3	13.7	1.0	483
Pynthorumkhrah (CT)	50.0	49.7	0.3	300
Shillong Cantt. (CB)	32.8	50.0	17.2	64
Madanrting (CT)	62.8	35.8	1.4	218
Nongmynsong (CT)	36.5	57.7	5.8	156
Shillong UA	65.0	33.4	1.6	3382

Table: 16
Percentage Distribution of Households with Access to Improved Sanitation

Town's Name	Flush Toilet to Sewage Sources[4]	Other Improved Toilet facilities [5]	No Access to Improved sanitation[6]	Total Number of Respondent
Shillong Municipality	86.2	2.2	11.7	1698
Mawlai CT2	74.3	22.7	3.0	463
Nongthymmai	89.4	3.9	6.6	483
Pynthorumkhrah	75.0	22.3	2.3	300
Shillong Cantonment	45.3	3.1	51.6	64
Madanrting	87.2	11.9	0.9	218
Nongmynsong	60.3	24.4	15.4	156
Shillong UA	82.1	8.7	9.2	3382
India (Urban)*	22.9	39.6	37.5	2728

Note:
4. Flush to piped sewage System, flush to septic tank etc.
5. Pour flush latrine, covered dry latrine etc
6. Unprotected dry latrine, bucket latrine, no facilities, other etc
* *World Health Survey, 2003, India, WHO-India-WR Office, New Delhi, 2006, P-50.*

Table: 17
Percentage Distribution of Households with Access to Improved Sanitation

Name of the Ward/town	Flush Toilet to Sewage Sources[4]	Other Improved Toilet facilities [5]	No Access to Improved sanitation[6]	Total Number of Respondent
Laitmukhrah	95.9	0.0	4.1	146
Laitmukhrah2	84.2	3.5	12.3	57
Laitmukhrah3	94.2	2.3	3.5	86
Laitmukhrah4	95.6	0.0	4.4	45
Malki1	87.2	0.0	12.8	78
Malki2	82.7	0.0	17.3	52
European Ward	85.3	8.0	6.7	75
European Ward2	89.7	1.7	8.6	58
Police Bazar	96.0	0.0	4.0	25
Jail Road1	89.1	0.0	10.9	55
Jail Road2	88.0	4.0	8.0	25
Mawkhar1	93.6	2.1	4.3	47
Mawkhar2	65.1	9.5	25.4	63
Jaiaw1	95.2	2.4	2.4	42
Jaiaw2	95.0	5.0	0.0	40
Jaiaw3	97.5	2.5	0.0	79
S.E. Mawkhar	59.5	0.0	40.5	42
Makhar	91.3	0.0	8.7	46
Mawprem	87.9	0.0	12.1	33

Mawprem2	69.8	3.4	26.7	116
Mawprem3	75.2	1.0	23.8	105
Kenhes Traces1	89.7	3.4	6.9	29
Kenhes Traces2	94.8	2.1	3.1	96
Laban1	100.0	0.0	0.0	35
Laban2	82.7	1.2	16.0	81
Lumparing1	79.0	1.2	19.8	81
Lumparing2	82.0	4.9	13.1	61
Mawlai	74.3	22.7	3.0	463
Nongthymmai	89.4	3.9	6.6	483
Shillong Cant	45.3	3.1	51.6	64
Madanrting	87.2	11.9	0.9	218
Pynthorumkhrah	75.0	22.3	2.7	300
Nongmynsong	60.3	24.4	15.4	156
Total	82.1	8.7	9.2	3382