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Unplanned urbanization: Assessment through calculation of environmental degradation index

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ABSTRACT: Urbanization is an inevitable phenomena for the country like Bangladesh. The push and pull factors help to migrate people from rural area to urban area. As a result haphazard and unplanned urbanization create environmental degradation. Survey data reveals that inadequate solid waste disposal services, lack of adequate public water supply, traffic congestion, water logging, air pollution, noise pollution, hill cutting are the main problems in the city area. Concentration of dust as well as SOx, NOx exceeded the allowable limit at the selected points. Groundwater level of Sylhet city has a considerable lowering over the last few decades. It has lowered from 3380 mm below ground in 1982 to 7880 mm below ground. Sylhet is located in highly seismic risk zone but most of the buildings and other structures in this area are constructed without considering earthquake risk. Environmental degradation index was calculated based on economical condition of the country.

Key words: *Environmental degradation, urbanization, Pollution, Environmental index, water logging*

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INTRODUCTION

As the city and its surroundings continue to develop, the watershed or flood basin is expected to undergo urbanization. For the downstream city, urbanization in the watershed can mean increased flood peaks, water volume and pollutant loads. More subtly, it may also reduce water that sustains the ground-water system and adversely affect downstream ecosystems that depend on ground water such as the Pheasant Branch Springs. The relation of storm-water runoff and reduced ground-water recharge is complex because the surface-water system is coupled to the underlying ground-water system. In many cases there is movement of water from one system to the other that varies seasonally or daily depending on changing conditions. Therefore, it is difficult to reliably determine the effects of urbanization on stream base-flow and spring flows without rigorous investigation. Moreover, mitigating adverse effects after development has occurred can be expensive and administratively difficult. Overlying these concerns are issues such as stewardship of the resource, the rights of the public, and land owners' rights both of those developing their land and those whose land is affected by this development. Sylhet, north–eastern part of Bangladesh became a Municipality in 1878 covering an area of 5.82 square km. situated on the north bank of the Surma River. It is one of the rapidly growing metropolitan areas, located in the northeast region of Bangladesh and situated at 28.85° latitude and 98.80° longitudes. According to the census of 1872 the population of the Sylhet Municipality was 16,846 (Ahmed, 2003). Although Sylhet Municipality was established almost 127 years ago, actual expansion of municipal area has been started since 1971. The 1971 war of liberation accelerated the rate of migration from rural to urban areas, and this large exodus led to rapid urbanization (Rahman *et al.*, 1990). In addition, Sylhet is also a home of several thousand expatriate workers who leave Sylhet for working abroad, leaving behind their children and spouses. For the sake of children's education and also to avail urban amenities many of the migrants' families moved to the municipal areas of Sylhet and thus further enhancing the urban population. At present Sylhet city Corporation has an area of 26.5 square km., with an estimated population of around 500,000. But the city has been developed in an unplanned and haphazard way. Serious problems of environmental degradation in Sylhet city stemming from urbanization may be evaluated in the form of land use alterations, inadequate solid waste management, traffic congestion, water logging, drainage

congestion, inadequate public water supply, lack of proper sanitation, air pollution, noise pollution, hill cutting, lowering of groundwater level, etc. The aim of the study is to figure out the problems related with unplanned urbanization of Sylhet city.

MATERIALS AND METHODS

A questionnaire was prepared and asked regarding their feeling about air pollution in Sylhet city. Data was collected from different hospital, clinics, households etc from July 1999 to July 2004 in Sylhet city. As Sylhet city is not an industrial area traffic movement contribute maximum concentration to air pollution. So it was maintained that the sampling error would remain in a certain limit so that in the future analysis the confidence level will be 95%. Then random sampling was done. Every 30$^{th.}$ shop's or household's family chief or hospital's doctor in every ward was interviewed based on questionnaire. The distribution of the respondents was as follows by number of households (Table1).

Table1: Distribution of the respondents in zone wise

Zone wise	No. of households
1, 2,3,4,5	17
6,7, 8	34
9,10, 11,12	24
13,14,15, 16	24
17,18	29
19, 20,21	29
22,23	29
24, 25	24
26,27	24
Total	234

Therefore, the randomness of the sample, which was 234 in size, was kept. In each unit, proportionate representation of social class was mentioned in selection of the households. However, in order to present the actual picture of the existing condition of city corporation, in terms of social categories samples were distributed as follows: poor 147, middle 75 and rich 12. Number of poor and middle class respondents was proportionately much higher like the universe and henceforth it can easily be assumed that the sample represents the population exactly. Using a face-to-face technique, empirical data were collected for the study by sample survey method where the universe contains 200 experts' opinions. Based on the information and the data, collected from the first visit, several meetings of the team members were held and an interim test information-checklist was prepared. The information-checklist was pre-tested in the non-sampled area through a pilot survey before finalization. The final information-checklist contained both pre-coded and open-ended questions. The satellite images of Sylhet City were analyzed for the year 1977 and 1989. Then three qualitative maps were prepared showing different land use patterns of Sylhet city for these three years. Numbers of bins available for waste storage, mode of waste collection, efficiency of collecting vehicles, etc. was observed through questionnaire survey. Number of registered motorized and non-motorized vehicles was collected from Roads and Highways Department. Parking studies were conducted at the busiest places such as Amberkhana, Bondorbazar, Chowhatta, Darshan Deuri etc. In the present study number of vehicles parked both on street and off street was observed through survey. Commercial areas such as Zindabazar, Amberkhana, Bondorbazar, Modina market, etc were selected. The parameters of air pollutant (SO_x; NO_x) were measured method described by Rahman *et al.*, (1998). For evaluating the effects of air pollution on health a questionnaire was prepared by asking doctors at different clinics, hospitals, etc. Noise levels at various silent zones such as schools, colleges, hospitals, mosques, etc. at different distances away from the roadside were measured with Sound Level Meter. The flowchart of methodology is presented in Fig. 1. The places, which are most frequently affected by water logging, were selected through a discussion with the City Corporation officials.

RESULTS

Analysis of land use change using satellite image

False color composite (FCC) image of LANDSAT, TM and SPOT images were used for visual interpretation of land use change. From the selected images of the year 1977 and 1989 (Figs. 2 and 3), the areas of changed land use were determined by digital planimeter. It was found that the area of Sylhet was 14.82 square kilometer in the year 1977 and in the year 1989, it was 32.82 square kilometer. Therefore the areas of land use change are positive, that means city area has been changed from agriculture to housing. About 2.68 square kilometer of water body has been detected which have been filled up by earth for urban development. Housing construction has been increased from 12.97% to 38.19% (percentage on the basis of total city area). The areas found from planimeter reading were nearly same as that measured by Bangladesh Bureau of statistics. The percentage error for area calculation was only 0.157%.

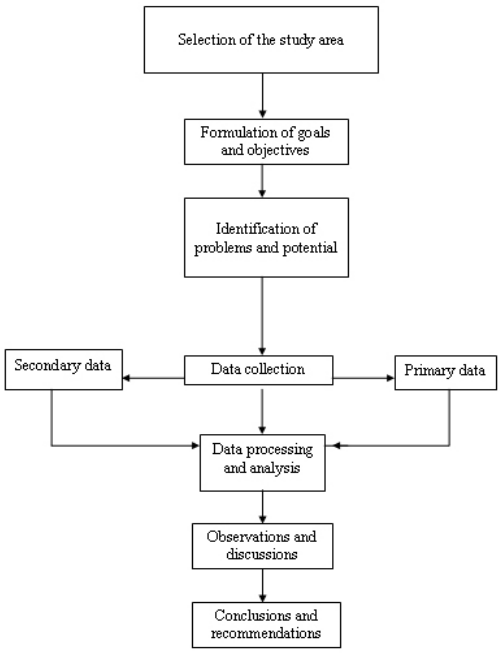

Fig. 1: Flow chart of methodology

Solid waste disposal and garbage problem

The City Corporation authority has set up only 160 concrete made bins for waste disposal in some places of the city area. About 240 tones of solid waste are produced everyday from domestic, commercial and clinical sources. Everyday City Corporation dumps about 135 tones of waste manually from main and other roads and the remaining (44%) are consumed by the city (Ahmed, 2001). Although the open or closed lorries used for solid waste disposal are not be allowed to collect garbage from the waste disposal places after dawn, they are always used during the day time, creating air pollution, odor nuisance, aesthetic problems and even sometimes traffic jams at some places. Besides these facts, some community organizations are now dumping waste in an abandoned pond near Akhalia along the main roadside, which is completely unhygienic. The solid wastes accumulated in the areas of Sylhet Cityare derived from various sources. They are (i) household or domestic wastes derived from households and domestic holdings (ii) commercial refuse derived from commercial offices and business holdings (iii) institutional refuses from

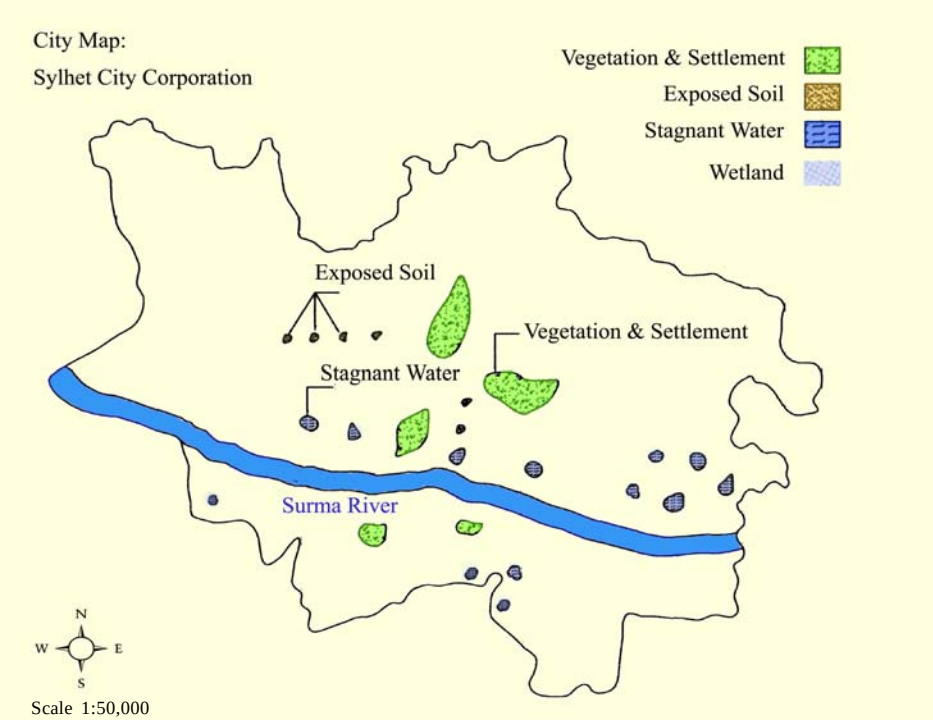

Fig. 2: Map showing land use pattern of Sylhet in 1977

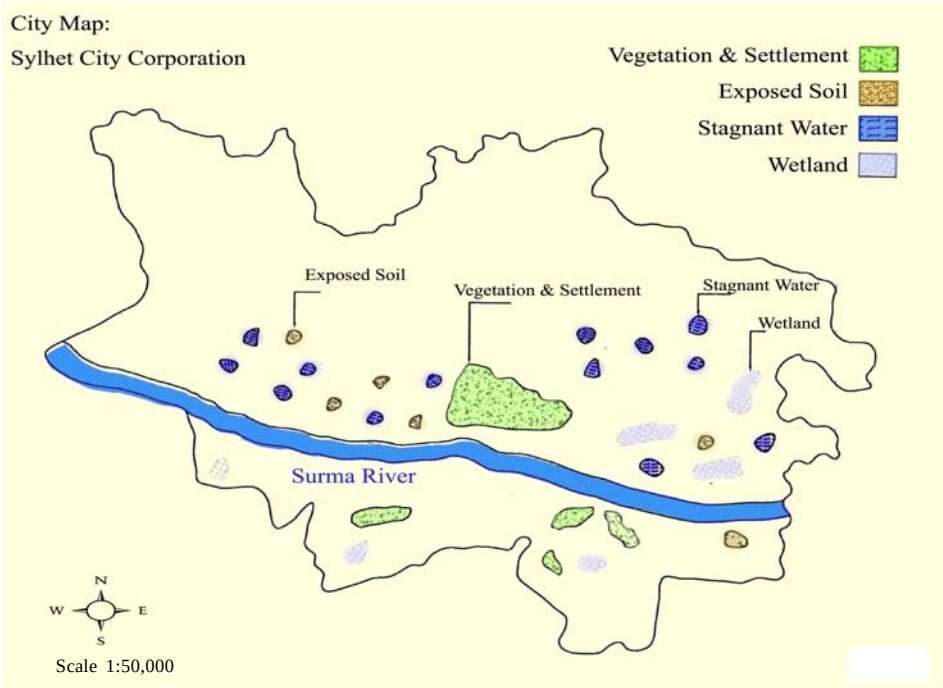

Fig. 3: Map showing land use pattern of Sylhet in 1989

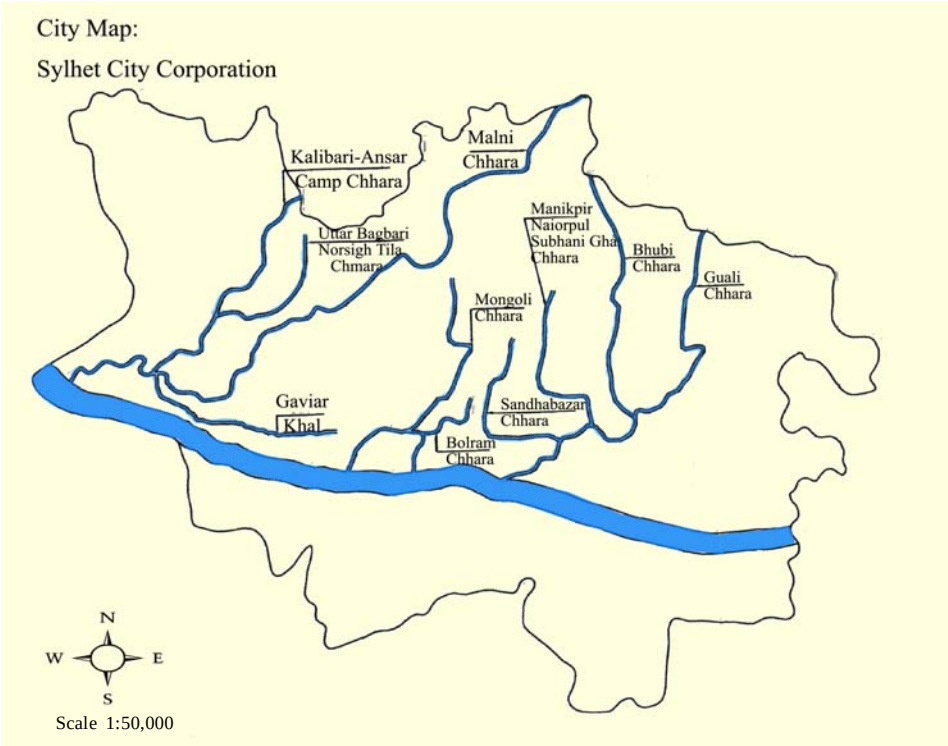

Fig. 4: Map showing natural canals passing through the city area

community holdings like schools, colleges, mosques, temples, churches, clubs, community centers, auditoriums, and community organizations (iv) street sweepings from all kinds of streets including highways and arterial sub arterial roads (v) sanitation residues from all types of sanitary facilities e.g. human excreta, toilet papers etc. (vi) hospital wastes and (vii) dry excreta of cows, chicken etc. A town of Sylhet's size is normally expected to generate waste of about 0.3 kg/cap/day. On this basis the waste generated in Sylhet town is 23.5 tones per day. It was found from the survey work that the generation rate was about 0.36 kg/cap/day. This rate is less than the generation rate of Comilla (0.46 kg/cap/day), Chittagong 0.66 kg/cap/day) (Alam and Hasan Bhakt, 2003; Asia Arb, 2000 and Salam, 2000). Household wastes disposal is one of the main problems across the city. Among the different options of waste disposal, 50 (21.4%) respondents generally throw their wastes into nearby ponds. 56 (23.9%) respondents generally dump their waste into nearby drains. The figure is higher than the other similar size urban areas such as Khulna (Rakib, 2001). From the present study, it was found that about 14.5% of the sampled household discards their wastes in their respective compound, while 12% used bins supplied by the Urban City. About 10.7% households throw their garbage on the roadsides. It was also found that either the Urban City or the local people improperly handle the open waste collection points. There was no house-to-house waste collection system in Sylhet. There fore, disposal of household waste have become a breeding ground of diseases. In addition, it was observed that solid waste was indiscriminately dumped into roads sides, open drains, leading to serious health risks and degradation of living environment for the people of town. Dumping of domestic wastes in the home and roadside arenas was found to become a potential source of pollution in the localities. In other words, garbage pollution was serious environmental concerns at Sylhet. About 63% households were found to have their own drainage system (internal) 39% households having their internal drainage systems, directly connected with City's drainage system. In contrast, according to the majority of the respondents (63.4%) existing drainage facilities maintained by the Urban City were not satisfactory and sufficient. The most serious health threat is expected from pathogens. The corrosive and flammable nature of unprocessed solid wastes (broken glass, metal edges, chips, battery etc.) pose risk to workers and scavengers. On the other hand, the off-site nuisance and health hazards are due to the odorous gases emanating from solid waste disposal sites. Offensive odors may be generated during active stage of composting. Formaldehyde is a common gas emitting from solid waste disposal site. Others are hydrogen, sulfides, ammonia, etc. A rough indicative estimate of maximum distances of health and odor impact was computed using *Gaussian Distribution Model* for area sources with wind speed of 3 m/sec at a temperature in the range of 24°-35 °C. The maximum missing height has been assumed to be 1500m and minimum mixing height as 450 m. Formaldehyde is common emitting gas from solid waste disposal site. Others are hydrogen, sulphide, ammonia. Since formaldehyde has lowest value of TLV and odour threshold (DOE, 2002), safe distances in terms of health impact and odour impact have been computed. Considering formaldehyde emission of 0.2 g/sec-m^2 (DOE, 2002) for 1000 MT solid waste occupying an open area of 0.1km^2; safe distance has been computed and shown in table 2. It has been calculated based on future urban plan of Sylhet Municipality (200 MT) (Shebliee, 2001 and Ibney and Ali, 2005). Results indicate that for a 200 MT plant the safe distance will be about 800m from the disposal site in terms of odor impact while it will be 500 m regarding health impacts.

Traffic congestion

The intolerable traffic congestion of Sylhet city has become an everyday certainty and a nightmare for the city dwellers. There are several of reasons behind this problem. Effective reasons include: significant increase in population and also all types of vehicles, poor transportation and infrastructure planning, simultaneous presence of motorized and non-motorized vehicles on the same street, traffic mismanagement-violation of traffic rules and regulations and other issues (political reasons, lack of manpower, etc). Sylhet City has several types of vehicles. Income-wise the use of different transports is as follows:

- Higher Income Group: Car, micro Bus and other private vehicles.
- Middle Income Group: Rickshaw, auto rickshaw, Bicycle,

Motor Cycle, Car, Bus, Minibus.

- Lower Income Group: Bus and Tempo.
- Goods Delivery: Truck, Pick up, Van, Human Driven Van.

Rickshaw is the most frequent mode of transport followed by tampo, own vehicle (motor cycle and private car), babi taxi, hired car and public bus. The total number of registered rickshaws in Sylhet is about 10204.

Table 2: Safe distance to avoid health impact and odor impact from solid waste dumping place or composting plant

Capacity	Impact distance in m					
	Summer		Winter		Monsoon	
	Odor impact	Health impact	Odor impact	Health impact	Odor impact	Health impact
500 ton	2.2	1.40	1.92	1.40	1.60	1.40
200 MT	800	500	700	500	600	500

Table 3: Traffic flow characteristics of the studied area

Road	No. of traffic lane	Average road width	Traffic flow	Actual traffic volume (PCU)	Theoretical traffic volume (PCU)
Amberkhana	Four lane	14m	Two way	7488	2500
Chowhatta	Four lane	17m	Two way	7318	2500
Zindabazar	Four lane	10m	One way	4948	2500
Bondor	Six lane	24m	Two way	8046	4200
Tilagor	Four lane	13m	Two way	5501	2500

But at present Sylhet has about 30000-40000 rickshaws, most of which are unauthorized.

The road hierarchy of Sylhet city is incomplete and in some major developed areas there is no road hierarchy (Haque, 2005). Old city area and some other places of the city have major access problems and it will likely worsen as development intensifies. The Table 3 clearly shows that at every intersection the actual roadway capacity exceeds the theoretical roadway capacity and the case is severe for Amberkhana intersection. In Sylhet city, most of the office buildings, market place, residential area, educational institutions, and commercial areas have been developed haphazardly. In these areas, particularly at peak periods the demand for parking space often exceeds the amount of space provided. In absence of adequate parking facilities (Kadiyali, 1997) in these areas, people have to park on the roads, which ultimately narrow down the capacity and effective width of the roads to a great extent.

Filling of natural canals and water logging due to unplanned urbanization

Water logging is a very common physico-hydrological phenomenon in the city of Sylhet. Even after a minor downpour the city of Sylhet experience such disturbing water logging very frequently. The main reason of water logging in the city is attributed to the drainage congestion in the city due to unplanned structural growth. Most of the natural canals (Figure 4) are encroached by earth filling and choked by deposition of city garbage for example a large drain just near Sandhabazar. One decade ago there were about 17 ponds in Sylhet city. These ponds used to carry a huge amount of rainwater. But now many of these have been filled for various purposes such as Dhopadighi (for the construction of "Osmani Children Park"), Laldighi (for the construction of Hawkers market), Masudighi (for the construction of private buildings), and Ramer dighi (for the construction of private buildings). Formerly, this canals and ponds used to carry a huge amount of surface run-off and daily wastewater and these were ultimately drained into Surma River. But now a day their effectiveness has been greatly reduced.

Urbanization and air pollution risk in Sylhet city

The following Table 4 shows the present condition of air quality of Sylhet city. It is clear from the table that the dust concentration was higher than the standard values. Rapid growth of traffic in Sylhet city due to urbanization causes air pollution. A questionnaire was prepared and asked regarding their feeling about air pollution in Sylhet city. Data was collected from different hospital, clinics, households etc. As Sylhet city is not an industrial area traffic movement contribute maximum concentration to air pollution. The Table 5 and Fig. 5 show the feeling of people regarding different diseases due to air pollution and hospitals records. Doctors were asked about the skin diseases, duration of respiratory diseases etc. Concentration of sulfur dioxide and nitrogen dioxide was not considered.

Table 4: Comparison of air pollution in commercial and mixed areas of Sylhet city with Bangladesh standard

Air pollutants	Sylhet	Bangladesh standards ($\mu g/m^3$)
SPM($\mu g/m^3$)	4,666.67	400
SO_2 (ppm)	0.3288	100
NO_2 (ppm)	0.0371	100

Table 5: Mortality and Morbidity from exposure to air pollutants

Case		High exposure (drivers, traffic police; hokkers)	Moderate exposure (commuters)	Average exposure (rest of people)
Mortality	Excess death	84	59	526
Morbidity	Bronchitis	184	487	874
	Restricted activity	36,015	38,492	60,038
	Hospital diseases	823	468	1403
	Respiratory	1003	1987	2756
	Different symptoms	15,056	16,975	14,849

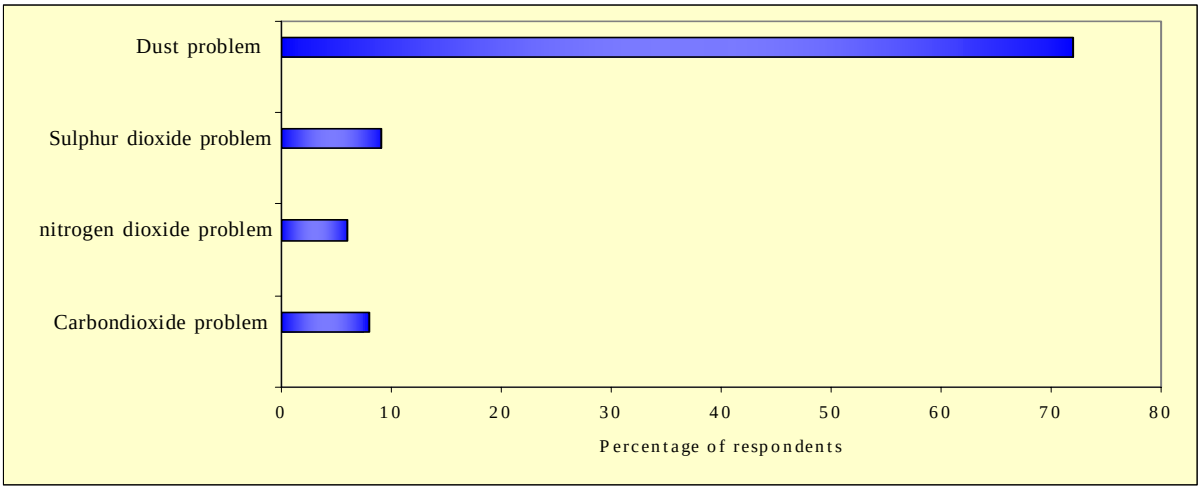

Fig. 5: Percentage of respondent regarding air pollution

Dose-response relationship is the process of quantitatively evaluating the toxicity information and characterizing the relationship between the dose of a chemical and the incidence of specific biological effects in the exposed population. The dose response equations are

Life time risk= average daily dose (mg/kg/day) * potency factor

Life average daily dose = {(total dose, mg) / (body weight, kg)}* lifetime (days)

Total dose = concentration* exposure duration* absorption fraction*intake rate

Exposure risk to air pollutants (mainly dust) is estimated from dose response relationship following Ostro (Khan, 2005) assuming potency factor based on Environmental Protection Agency (EPA). These results are comparable to the result of dose response relationship of Mumbai City (Somalwa *et al.*, 2000).

Excess death = 0.000812*(dust concentration – 47)* P*C

Number of cases for bronchitis per 1, 00,000 persons = 6.2* (dust concentration – 47)*P

Change in restricted activity days per person per year = 0.0475*(dust concentration-47)*P

Change in respiratory diseases per 1, 00,000 persons = 1.11 *(dust concentration -47)*P/1, 00,000.

Different symptom per person per year = 0.173*(dust concentration -47)

where P= number of people exposed

C= 0.0076 (mortality rate)

Since more than 70% respondents identified dust as the major air pollutants in Sylhet city, hence the effects of dust on both mortality and morbidity were estimated from dose response relationship following Ostro (1994) and are shown below. Maximum concentration dust was found 4,666.67µg/m^3 at Zindabazr (Rahman and Nag, 2005).

Number of cases for excess death =19

Number of cases for bronchitis per 100,000 persons = 443

Change in restricted activity days per person per year = 219

Change in respiratory diseases per 100,000 persons = 295

Different symptom per person per year = 799

Groundwater fluctuation in Sylhet city

Urban areas generally generate more run-offs, but they increase the area of impervious surface thereby reducing the infiltration of rainfall and lowering the

water tables. Open spaces in urban areas are now being filled with a number of buildings. Large unbroken expanses of concrete or asphalt or etc during construction works can also prevent precipitation from entering the soil to replenish groundwater. Subsidence is a most common problem occurring due to extensive ground water extraction. Experiences from other countries indicate that at least 9 meters of permanent lowering of groundwater table causes 30 cm of land subsidence (Torrey, 2004 and Uddin and Mandal, 2002). Therefore it is likely that land elevations in many parts of Sylhet city have been lowered contributing to increased flood depth. Urbanization increases the area of impervious surfaces thereby decreasing infiltration of rainfall. It is clear from Fig. 7 that water level declined with time (in Fig. x means year; year 1, 2, 3… from year 1982).

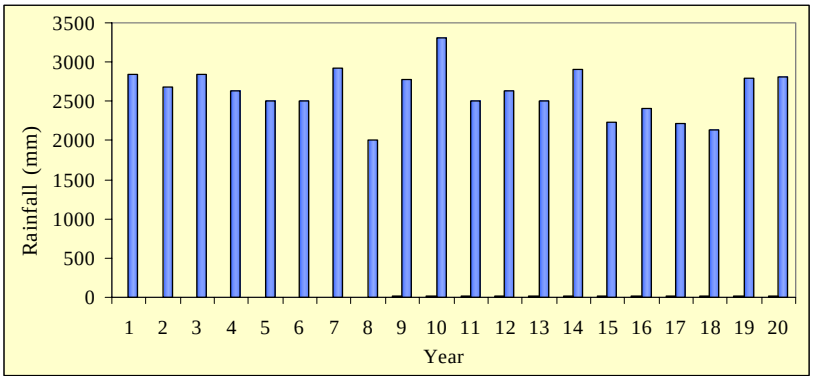

Fig. 6: Decrease in yearly rainfall over the last two decades

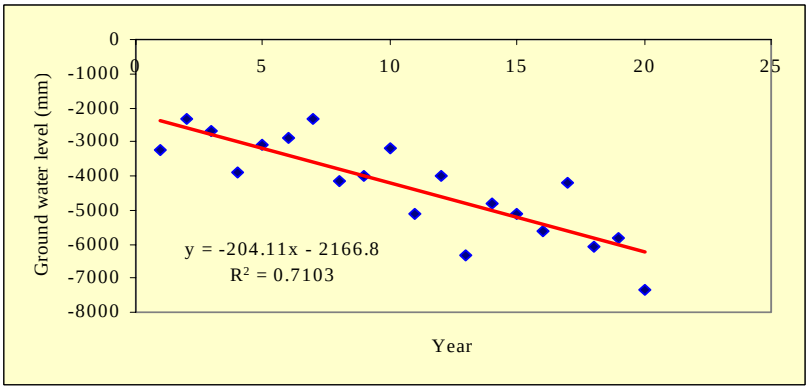

Fig. 7: Yearly variation of ground water level over the last two decades

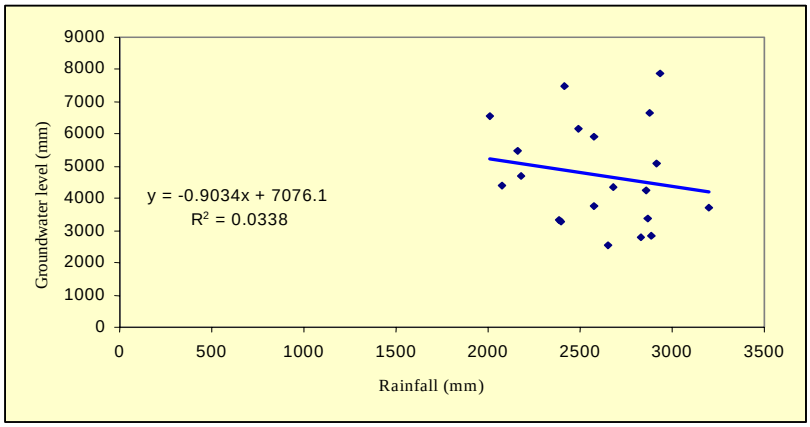

Fig. 8: Variation of ground water level with rainfall over the last two decades

It is evident from Fig. 8 that groundwater recharge responded linearly with the rainfall and the recharge pattern of Sylhet can be expressed by the equation GWR = 7076.1 – 0.9034 (TRF) (R^2 = 0.0338)
It is observed from Fig. 8 that although the amount of rainfall is increasing (Fig. 8), it cannot replenish ground water because the urban areas are now becoming impervious thereby preventing rainwater to enter through the soil. As a result ground water level in urban areas is lowering day by day.

Effect of unplanned urbanization on surface water quality

800 data have been collected for determining water quality indices at different locations at different period (Hossain, 2001; Muyan, and Mamun, 2003 and Shiddiky, 2002). A computer program in MATLAB was developed for finding out the relationship among the parameters and their impact on water quality. These parameters are DO, BOD, COD, SS, AN, pH. The expression was found as WQI = 0.22*SI of DO+ 0.19*SI of BOD+ 0.16*SI of COD+ 0.15*SI of AN+ 0.16*SI of TS+ 0.12*SI of pH for year 2004; Where SI is the sub-index of each parameter. However the water quality equation was as follows for year 2000 WQI = 0.12*SI of DO+ 0.15*SI of BOD+ 0.12*SI of COD+ 0.09*SI of AN+ 0.134*SI of TS+ 0.10*SI of pH; Where SI is the sub-index of each parameter for 2000. The following Table 6 shows the WQI at different locations (Chattak, Near King Bridge, Tokerbazar) at different period.

Seismicity and urbanization

Bangladesh lies in the southern vicinity of the Shillong plateau which is the center of a strong seismic activity in the whole region. This seismic center greatly affects almost the whole of Bangladesh and causes huge damage in Sylhet, north-Bengal districts (Rangpur, Dinajpur) and Mymensingh-Dhaka belt of the country. The degree of destruction due to earthquake depends on how devastating the earthquake is as well as how the building structure, soil condition and population density are near the epicenter. The tectonic framework of Bangladesh indicates that Sylhet city, due to the presence of Dauki fault system of eastern Sylhet, the deep-seated Sylhet fault and proximity to the highly disturbed southeastern Assam with the Jaflong thrust, the Naga thrust and the Disang thrust, is a zone of high seismic risk. Sylhet city is located in the seismic zone 3 and so it is highly vulnerable to earthquake. In the last 150 years three earthquakes of magnitude greater than 7.5 occurred in Sylhet (Ansary, 2002). The Sylhet city is a part of Surma basin, which consists of four types of landforms such as (i) Sylhet depression, (ii) lowland flood plains (iii) alluvial fence and (iv) up-lands. The earthquake risk at any location within the City Corporation can be calculated on the basis of Severity Index, Soil Stability Factor. Earthquake Damage Index (EQDI) can be calculated using the following formula
EQDI = Earthquake Risk Factor* {1+ (10-soil stability factor)/10}
Earthquake Risk factor = S/ (0.1+ $d^{1.1}$), where S= severity index; d = distance from the fault in feet. Based on these factors along with population density of zone wise in Sylhet city, hazard maps was constructed (Fig. 9).

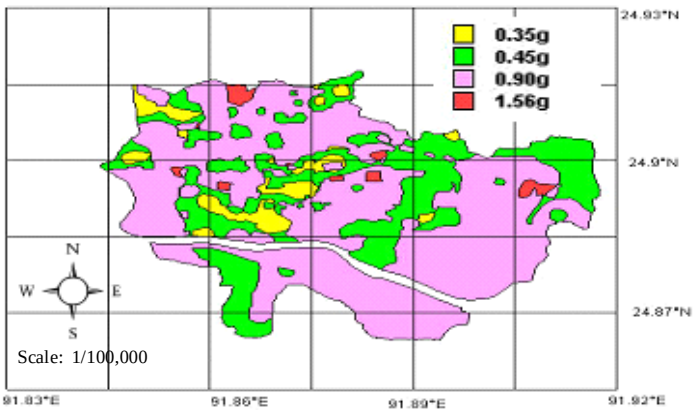

Fig. 9: Earth quake hazard map of Sylhet city

Determination of environmental degradation index

Murthy and Jha (2001) considered the fresh water withdrawal per capita, annual rate of deforestation, emission of carbon di-oxide, paper consumption per 1000 persons as the indicators for human development as well as environmental degradation. They proposed the following equation for determining environmental degradation index based on consumption using global environmental Kuznet curve.

EDI (for developing country) = 73.21-2.15 (HDIR) $+0.2(HDIR)^2 -6.05(HDIR)^3$

But it is difficult to measure Human Development Index Rank because of scarcity of available data especially for developing country like Bangladesh. In another study Cherp and Mnatsakania (2002) expressed their opinion that environmental degradation should be monitored using a set of indices. The indices are aerosol index, snow cover index, deforestation index, land use change, water deficit index, and vegetation index. But the aerosol and snow cover problems are not a matter of concern for Bangladesh. Instead of these two, air pollution, earthquake damage, water logging problem and noise pollution etc are matter of concern. Moreover, the urban centers in Bangladesh are growing at a rate out pacing the growth of service facilities. Serious problems of environmental degradation stemming from urbanization may be evaluated in form of (i) land use alternations, (ii) inadequate shelter, water/ sanitation, and other facilities in slums and other urban poor areas, (iii) degradation of community ambient environment and (iv) little control of industrial and medical wastes disposal (v) uncontrolled growth of high-rise buildings (vi) drainage congestion and (vii) inadequate solid waste management facilities. The environmental problem in Bangladesh urban centers is more with urban poor/slum areas, which cannot afford a reasonable level of service. In order to understand the situation, Environmental Degradation Index (EDI) can be a suitable indicator.

$$EDI = \sum_{j=1}^{8} w_j X_j$$

where w_j = j-th component weight-age factor

X_j = value of the j-th variable

36 experts' are asked about the problems of the city and rank them according to their responsibility for environmental degradation due to unplanned urbanization. The ranking and the respective initial weight-age is explained in Table 7. Then 36 experts were asked to rank one criterion such as solid waste as per their responsibility and role in environmental degradation. By multiplying the initial weight-age of the criteria and no of respondents, gross weight-age is calculated. Similarly the weight-age for all the criteria estimated on the basis of expert survey, and the corresponding temporary weight-age were calculated. The whole methods were described in the books (Papacostas and Prevedouros, 1993). Then the final weight-age (w_j) was calculated. In order to evaluate the value of the above mention problems in a particular country the concept of Murthy and Jha (2001), which was used in their article, has been applied based government paying interest to combat the problems. The ratios of the paying interest to combat the problems with the most important and interested issue of the Government of Bangladesh are

Education: SW: TC: EH: SWP: GWF: LUC: WL: AP= 39:3: 1.5: 1.5:2.5: 0.5: 2:1.5: 0.5

The above relationship or ratios varies with the economic condition of the countries. In developed country, the contribution towards different types of pollution by government is more than that of the developing countries. So, these ratios will vary with the Human Development Index Rank. It is clear from the above table 8 that the EDI is 1.844 for Sylhet. It indicates the environmental degradation and problems of Sylhet City are alarming. Any value greater than 0.25 is a matter of concern. According to concept of Murthy and Jha (2001), the position of Pakistan and Bangladesh on the view environmental degradation is out of 140 counties of World. It is better to be the value of EDI less.

Table 6: Water quality indices values of Surma river

Time	Year 2004			Year 2000		
	Chhatak	Tokerbazar	Near King Bridge	Chhatak	Tokerbazar	Near King Bridge
January	70.20	69.10	68.76	81.23	75.23	73.33
March	69.08	68.12	67.23	76.23	74.12	71.45
June	68.23	66.5	64.34	72.34	70.34	69.45

Table 7: The ranking and the respective initial weight-age

Rank	I	II	III	IV	V	VI	VII	VIII
Initial weight-age	8	7	6	5	4	3	2	1

Table 8: Calculation of final weight-age and determination of Environmental degradation index

Criteria	Gross weight-age	Temporary weight-age	Final weight-age	EDI
Solid waste	262	5.4	0.20	0.6
Traffic congestion	234	4.85	0.18	0.27
Earthquake hazards	190	3.95	0.146	0.219
Surface water pollution	188	3.91	0.144	0.36
Ground water fluctuation	144	3.00	0.11	0.055
Land use change	128	2.66	0.10	0.20
Water logging	110	2.29	0.08	0.12
Air pollution	48	1.00	0.04	0.02

DISCUSSSION AND CONCLUSION

Sylhet city is becoming extremely crowded. The city area is endowed with educational institutes, residential areas, hotels, community centers, restaurants, banks, pharmacies, office building, health clinics, etc. but these have been developed in an unplanned way. This unplanned urbanization gave rise to severe environmental problems in the city area. Some emergency planning policies can be suggested for the development of Sylhet city like as area development policies which include development of new areas like Upashahar, Korer Para Housing Estate, Bagbari Housing Estate, Tilagor, Surma residential area, etc with all infrastructure service and urban facilities to reduce the pressure at urban center, accelerating the rate of development in the designated areas of urban fringe like Tilagor, Akhalia, Kadamtoli, etc., land resource optimization, gradual dispersion to satellite town like Upashahar, Khadimnagar, South Surma, etc and also infrastructure development policies like incremental road network development, development of bypass roads to relieve the pressure on existing urban network, preservation and maintenance of the low lying lands, ponds, depressions, etc for flood retention as a means of a better solution to existing water logging situation. However, detailed study, if possible, should be carried out to establish a more generic picture of this city, its problems and potentials and also the way to improve the situation.

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