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Quantification of the Environmental Degradation due to the Urbanization of Dhaka Narayanganj Demra (DND) Project Area in Bangladesh

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I. INTRODUCTION

Dhaka-Narayanganj-Demra (DND) Project area is located between the cities of Dhaka and Narayanganj in Bangladesh and bounded by the Buriganga and the Shitalakshya River. It was started in 1964 and completed in 1968 at a cost of Tk 22.9 million. The area is about 56.79 sq. km and about 800,000 people are living here. The project provides flood control for 4,860 ha, irrigation for 6,070 ha, pumped drainage for 4,860 ha and gravity drainage for 2,470 ha of land^[1, 3]. But, as the project is located close to Dhaka city, urbanization is taking place rapidly. So the initial

objective of boosting agricultural production has been frustrated. A snap of Google map of the DND project area (mentioned as our study area) is shown in Fig 1.

Most of the DND Project area has now become part of the suburban areas of Dhaka City due to land use transformation in its periphery in the last three decades. With the increase in residential houses, commercial enterprises and industrial concerns, there has emerged a necessity of additional roads, water bodies etc^[2]. But adequate drainage facilities is yet to be developed to cope with the changing situation of additional surface runoff caused as a result of urbanization with the increasing trend of population within the project area. In recent years the DND project area is facing acute problems of drainage congestion during resulting in severe sufferings to the inhabitants living within the area^[2, 3, 8].

Recently, one study conducted by Islam and Haque (2005)^[2] revealed that the inadequacy of drainage canals, filling up of drainage canals by solid waste, land use transformation through unplanned and rapid urbanization are the main causes of drainage congestion in the DND area. Besides that, water logging, water pollution (mainly from discharge of untreated industrial waste water particularly from dying industries), decrease in agricultural lands, decrease in pasture lands and fodder were identified major threatening to the environment of the DND area. Whereas the problem identified in health sector were: deficiency in pure drinking water, malnutrition and health hazards of the people especially the children; increase of water borne diseases, mosquitoes and venomous animals and insects for the DND area.

From our recent field visit experience in the DND project area, we observed that the housing companies have acquired cheap land in flood plains and developed residential colonies there, which are very vulnerable to flooding. Due to global warming, intensity and magnitude of different disasters are also increasing.

Here, the environmental degradation of the of DND area is a great concern because of (i) this area is very important as it is very near to the central Dhaka city (ii) Urbanization is progressing rapidly in this area with the increasing population and (iii) Vulnerability of the residents is also increasing rapidly. With considering the

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above concern, we feel that there is a need to have a decision support system for the planners and developers and political decision makers to take initiative for the reversal of the environmental degradation trends of DND area. In this study, we aim to assess and quantify the environmental degradation of the DND project area due to the unplanned urbanization. We hope that our quantification effort might be helpful for the concern decision making personnel for understanding the depth of degradation.



Figure 1 : Map showing the study area

II. METHODOLOGIES

a) Site visits

DND project area is located in the southeast suburb of Dhaka Metropolitan city and is stretched over Demra and Shampur Thana of Dhaka district and Shiddirganj and Fatullah Thanass of Narayanganj district. In the beginning of this study, we made frequent site assessment visits in between January to March, 2009 at different locations of DND project area as a part of reconnaissance study. From our site assessment visit, we tried to get an overall idea about the different important physical and environmental aspects of this area and we identified the important activities related to environmental degradation, selected point of water-air and noise quality sampling point. Regarding the sampling point selection, we tried to select a point which can give a quasi representative data to depict the overall

scenario of this area. We also collected some secondary data from various organization regarding the population, topography, climate, administrative division and public utilities (water supply, gas supply, electricity, sewerage coverage) in this area.

b) Socioeconomic survey

To assess the impact due to urbanization in DND project area, a socioeconomic survey was carried out in the DND area. It was a questionnaire survey, where about 2250 people of DND area were participated. The survey cohort included approximately 65 % male and 35% female, population from different professions and different ages. Survey area included Matuial union, Fatulla, Demra, Pagla, Kutubpur union, Jatrabari and Konapara. The questionnaire had four main parts including (i) general information regarding respondent and survey area, (ii) asking opinion about some ecological impact of urbanization (iii) asking opinion about some physio-chemical aspects of urbanization and (iv) human interest related impact of urbanization. Responses of questionnaire survey regarding some important environmental parameters are presented in Fig 3 by bar graph or pie chart. Represented value in first four bar graphs or pie chart indicates the percent (%) of people responded in each option.

c) Water, air and noise quality analysis

Surface and ground water samples collected from various places in between Sept. to Oct.'2009 and subsequently laboratory test program was undertaken to check the important water quality parameters. Water samples were analyzed for pH (USEPA 150.1; SM 4500-H+ B), color (USEPA 110.2; SM 2120 C), turbidity USEPA 180.1 Rev 2; SM 2130 B), Iron (USEPA 200.9 ; SM 3111 B), DO (USEPA 360.3, 360.2; SM 4500- O B,G), BOD₅ (USEPA 405.1; SM 5210 B; SM 5210 D) and COD (USEPA 410.4; SM 5220 D) in the Environmental Engineering Laboratory of the Dept. of Civil Engineering, BUET. Here, method of analysis is mentioned in the parenthesis beside the parameters mentioned above. Standard water quality analysis protocol as per as "Standard method (SM) or USEPA methods" were followed. Water quality analysis results are shown in the Table 1. Air quality parameters and ambient noise level were also measured at the different location of DND area and measured data pertaining to air quality and noise level are presented in Table 2 to 4. Noise levels were measured at different location using a calibrated TES 1350A sound level meter. The high volume sampler, Envirotech APM 460NL has been used to collect particulate matters in the air. In order to capture the gaseous matters in air Wolfpack Area Monitor has been used.

d) *Quantification of environmental degradation*

Considering urban point of view the environmental parameters are consider. List of environmental parameters are shown in the Fig. 2. Impacts due to each parameter are evaluated based on response of questionnaire survey; water, air and noise level monitoring data and from observation during site visits. To quantify the environmental degradation due to the urbanization, Environmental Evaluation System (EES) guided by Local Government Engineering Department (LGED), Bangladesh was followed [6]. The details calculations of quantifying assessment are shown in the Table 5.

III. RESULTS AND DISCUSSION

a) *Environmental factors considered for assessing environmental degradation of DND Area*

i. *Physico-chemical Parameters*

In the last few decades, DND area has been greatly changed with rapid urbanization and industrialization, especially through manufacturing industries, establishment of small and large-scale business enterprises, increase of multinational business and trade firms etc. Unfortunately, this rapid urbanization process has not taken place in a formal and planned manner. This unplanned approach of development has made this area “a land of unhealthy lifestyle”.

Surface water pollution: The Rivers Buriganga, Balu, and Shitalakshya together receive huge amount of untreated sewage and industrial liquid waste as well as municipal waste regularly through the three major canal systems and direct disposal. Water of the surrounding rivers and stagnant surface water body has already exceeded the standard limits of many water quality parameters, for example, DO, BOD₅, COD, color,

turbidity and so on. The input of high strength organic waste and inorganic solutions of metals in a reduced state of oxidation into a water course depleted the oxygen content of the water and ultimately will result in extinction of all oxygen dependent life.

Air, noise and odor pollution: Air quality data around the project site is not available, as there is no provision for monitoring air quality in the area. But during site visit it was observed that the ambient air quality in regards to SPM of the area is very dusty near the industrial and road side locations. We measured the level of different particulate and gaseous air quality parameters at different locations of DND area, which are presented in Table 2. Noise pollution is not very serious problem in DND zone but this problem is increasing day by day due to the rapid urbanization. Our measured ambient noise data at different location of DND area is presented in Table 3. Odor pollution is very serious problem in the DND area. Objectionable odors are coming out from the Matuail dumping site (a sanitary land fill site to dump the solid waste and the places where garbage are damped in open space.

Ground water depletion: In the DND area ground water table has become lower day by day in a very high rate. It is mainly due to extraction of huge amount of water for industrial use like dyeing factory.

Regional hydrology and flooding: The project area is affected by internal and external flood. External floods are caused in the low area by over flow of surrounding river and canal, while internal floods are caused by storm water due to rainfall and insufficient drainage facilities. Normally the low area of the project is submerged by over flowing of Balu River during August-September. Excessive local rainfall sometimes causes flood. The natural drainage system of the project area is being obstructed due to land filling activities for housing development project.

Table 1 : Water quality analysis result at different locations of DND Area

Sampling Location	Source Type	pH	Color	Turbidity	EC	DO	COD	BOD ₅	Iron
			Pt-Co unit	NTU	μs/cm	mg/l	mg/l	mg/l	mg/l
Jatrabari WASA pump station	^a GW	7.1	16	3.3	360	4.55	0.3	0.2	0.6
Mirdhabari WASA pump station	GW	7.12	13	0.5	217	4.6	0.8	0.3	0.02
DND canal water, Mirdhabari	^b SW	7.12	28	17	228	2.76	13	5.4	< 0.02
Pond water, Mirdhabari	SW	7.4	198	23	502	1.32	25	17	< 0.02
Pond water, Shanir Akhra	SW	7.12	252	30	833	1.21	20	12	< 0.02
Sitalakha River water	SW	6.7	170	67	462	2.2	17	10	< 0.02
Buriganga River water, Pagla	SW	6.9	210	18	504	1.8	12.5	10	< 0.02

^aGW: Ground Water, ^bSW: Surface water

ii. *Ecological parameters*

Fisheries: DND is the predominant spawning grounds of open water capture fishery. There exist four major fishery systems in the area. They are: River/Khal fishery, Flood plain fishery, Beel and reservoir fishery,

Culture fishery or aquaculture. Of the four (4) fishery systems, both the flood plain and beel and reservoir open water fishery are directly affected by the DND project, with embankment and the subsequent dry-up of flood plain due to the urbanization.

Aquatic biology: The main aquatic flora in this area is Kalmiiata, Shapla, Helencha, Kachuripana. The main aquatic faunas in this are arc different types of fishes. The fresh water fishes are carp (Rui, Katla, Mrigal, Kalibaus etc.), Catfish (Boal, Bacha etc.) and live fish (Koi, Singh, Magur etc.). The other fauna are Tortoise, Frogs, and Water snake etc. The aquatic live in the DND area reduced due to dumping of untreated chemicals of dying industries. Reduction of aquatic biology makes a higher negative impact on the environment of the project area.

Terrestrial flora and fauna: No complete list of terrestrial fauna is available in this region but a number of avian species were observed during field visit in this area including crow, eagle, shalik, sparrow etc. In addition to the avian species, the habitats are likely to contain reptile, mammals. The project area is similar to the character to many areas of alluvial delta in Bangladesh with mixed crop vegetation. Rice, other grains and seasonal vegetables are the main crops in the area. But in present days this area has become less suitable for the terrestrial flora and fauna due to rapid urbanization.

Wetlands: Few years ago there were many low land areas including ponds and reservoir in the DND zone which were actually wetlands. These low land areas serve as breeding ground of fish. At present significant portion of these low land areas are filled by rapid and unplanned urban growth. Industries and building are constructed by filling the wetland area; consequently destruction of aqueous ecology has become obvious for this area.

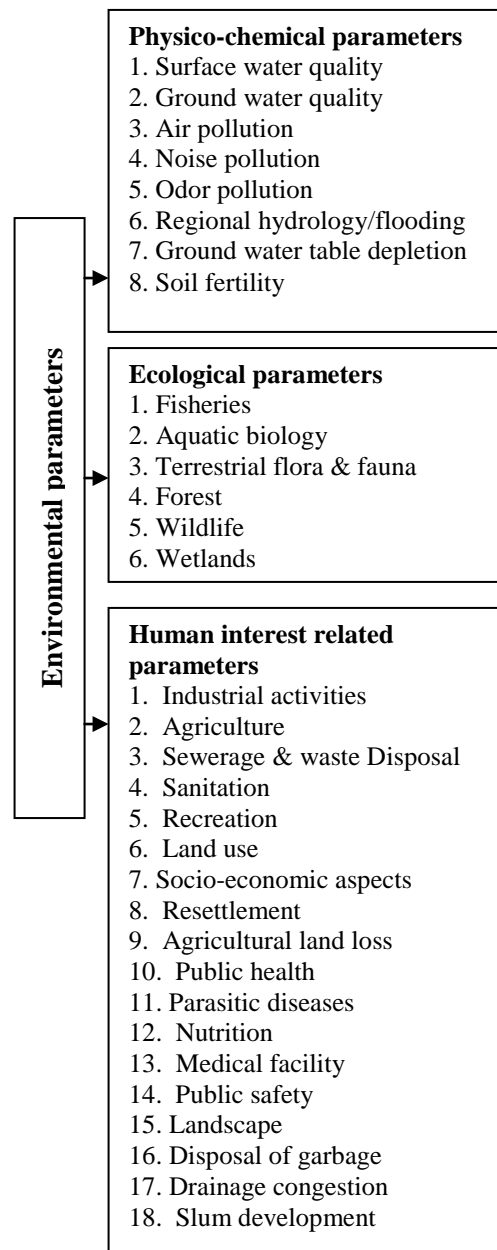


Figure 2 : List of the environmental parameters for assessing environmental degradation in the DND area

iii. *Human Interest Related Parameters*

Industrials activities: In the DND zone, most of the industries are developed in an unplanned manner and these are polluting the environment seriously. Our observation at the time of field visit revealed that most of the industries have no effluent treatment system and emission control system.

Sewerage and waste disposal: In the DND area sewerage system and Waste disposal system is not well organized. Some of the project areas have moderate access of sewerage and waste disposal system while most of the project areas have poor access of sewerage

and waste disposal system. The water borne sewerage system covered around 50% percent of the sampled households of the DND (N) project area. About 20% of the sampled households used septic tanks, of which most are imported type. Brahmanchiron had the highest percentage of households with sewerage facilities (65.2%) while Rajarbagh had the least (0.7%). There is no systematic waste disposal system in this zone.

Sanitation: The populations of the project area are presently using various alternative methods or ways of human waste disposal such as septic tank, pit latrine, leaching pit, katcha latrines and public toilet and open defecation. From the Questionnaire it is came out that almost 92% households have an access of pakha latrine. But this picture is totally different in the slum area, where poor sanitation (open latrine) and water supply system is a major threat to the environment.

Agricultural and recreational land loss: Actually DND project was for the promotion for agricultural activities in this zone but, urbanization trends destroyed the main aim of the project. Rapid urbanization in this area creates a negative impact on agricultural practice. The agricultural area in DND area in 1990 was 3173 ha. It is forecasted that in 2010 agricultural area will be reduced to 532 ha due to urbanization [6]. Large majority of younger of this zone are deprived from outdoor games/sports activities because of the reduction of the open space (playgrounds, parks, lakes).

Landscape: In the DND area, the flood free comparatively low value urban fringe land is going to be under tremendous pressure of development. The general characteristics of the area are conducive to additional development and there are sign of new

industries set up in this area. Due to the unplanned development of industries, distortion of natural landscape and natural beauty is highly noticeable in this area.

Drainage congestion: Since this area has no proper drainage system, excessive water logging is one of the most of the common problem in the rainy season. Due to rapid urbanization low lands are filled thus the problem of water logging is going to be more severe problem day by day.

Slum development: Due to rapid urbanization in the DND zone, many people are coming from the outside for work and consequently, for these very low income groups slums are developing in this zone.

Positive aspects of urbanization trends in DND area: Because of its proximity to the Dhaka city and also being relatively flood free, the DND area has been developed quite rapidly during the last decade, particularly in the Northwest corner. There are many industries are developed in the DND zone and these industries create employment opportunities. The newly constructed Dhaka-Narayanganj Spine Road has resulted in land speculation. In regarding land use pattern huge change has been seen in the DND area due to the rapid trends of urbanization. Currently RAJUK is preparing a housing development program for the area [3]. Land value in this area has been increased too high within a decade. Socio-economic aspects including educational status, occupational status, average monthly income, and monthly expenditure and housing condition have been slightly improved some parts of DND area.

Table 2: Measured air quality data at different locations of the DND area

Parameters	Measured Concentration			Bangladesh Standard (ECR, 2005) ^[10]
	Mirdhabari Bazar ^a	Fatullah ^b	Shiddirganj ^c	
PM ₁₀ (µg/m ³)	74	166	133	50 (annual average) 150 (24-hr average)
SPM (µg/m ³)	312	499	405	200 (8-hr average)
NO (ppm)	0	0	0	0.053 (annual)
NO ₂ (ppm)	0	0	0	
SO ₂ (ppm)	26.6	23.8	26.1	0.14 (24-hour)
CO (ppm)	2.6	4.2	3.9	35 (1-hour)
CO ₂ (ppm)	530	657	589	--
H ₂ S (ppm)	5.23	3.42	1.21	--
O ₃ (ppm)	0	0	0	--
TVOC (ppb)	1544	1245	1187	--

Note: Weather condition at the measuring time: Ambient Temperature (°C) 32.7^a, 33.2^b, 32.9^c; Relative Humidity (%RH) 71.7^a, 81.3^b, 74.6^c; Measuring date: 12 Sept 2009^{a,b} 13 Sept 2009^c; Measuring equipment: for SPM and PM₁₀ - Envirotech APM 460NL, for rest of the gaseous pollutant- Wolfpack Area Monitor; Measuring location: beside Mirdhabari school^a; beside main road^{b,c}

Table 3 : Ambient noise level at different locations of the DND area

Location	Time	Equivalent Noise Level, L_{eq}	Max	Min
		dBA	dBA	dBA
Jatrabari More ^a	Day	78.7	97.3	56.0
	Night	74.8	87.6	44.3
Mirdhabari Bazar ^b	Day	68.7	87.2	50.7
	Night	61.9	75.7	46.1
Fatullah ^c	Day	76.5	90.2	58.3
	Night	- ^e	-	-
Shiddirganj ^d	Day	73.6	86.4	66.6
	Night	-	-	-

Note: Measuring date: 12 Sept 2009^{a,b,c} 13 Sept 2009^d; Measuring equipment: TES 1350A sound level meter; Measuring location: Jatrabari bazaar to demra road^a, beside Mirdhabari school^b, beside main road^{c,d}; -^enot measured; noise level monitoring time at each location was about 20 minutes and equivalent noise level (L_{eq}) was calculated from about 100 observation recoded data

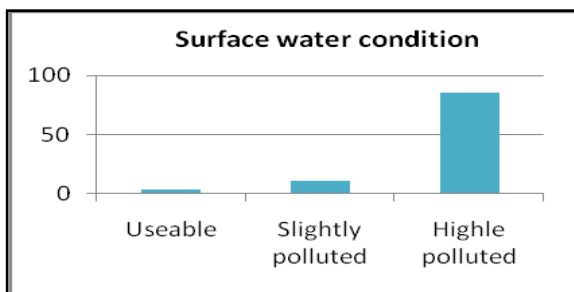
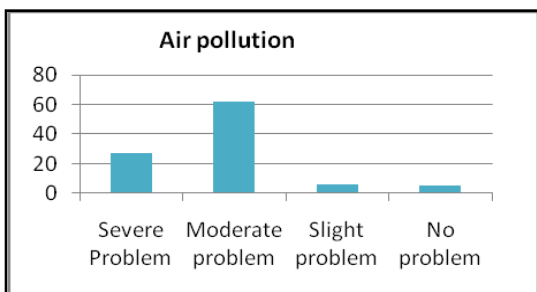
Table 4 : Bangladesh Standard for Noise Level at different types of areas (as per Noise Pollution (Control) Rules, 2006)^[11, 12]

Area type	Noise level (dBA)	
	Day	Night
Silent zone	50	40
Residential area	55	45
Mixed area	60	50
Commercial area	70	60
Industrial area	75	70

b) Assessment and quantification of environmental degradation

From the various literature surveys we found there are many approaches for evaluating the overall value of environmental quality considering some environmental factors [2, 4, 5, 6, 7, 9]. In our analysis, first we did a qualitative assessment ^a (see table 5) on each environmental factor based on our field investigation and public opinion survey. Next qualitative assessment was translated into quantitative approach. Both positive and negative environmental factors are considered to

assess the net environmental value of environmental quality. According to the LGED guideline for EIA^[5], the degree of environmental impacts due to urbanization of DND project consider within the range of -5 to +5 where -5 represent an severe negative impact and +5 represents the very high positive impact and higher the number, higher the degree of impact. We estimate the overall value of environmental quality following method of Environmental Evaluation System (EES) ^[5]. Details assessment and quantification results are shown in Table 5.



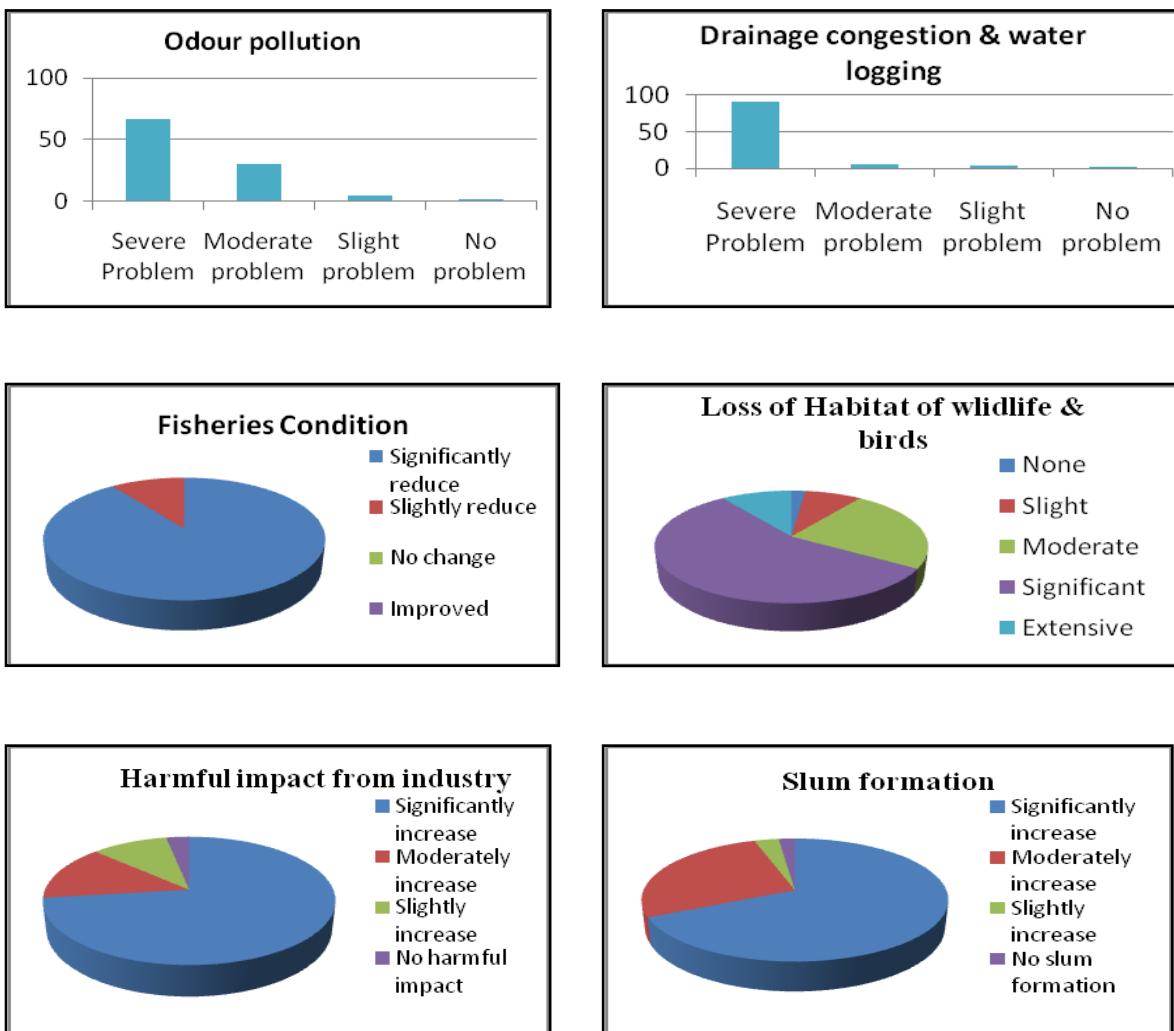


Figure 3 : Responses of questionnaire survey regarding some important environmental parameters. (Represented value in first four bar graphs indicates the percent (%) of people responded in each option. About 2250 people of DND area were participated in this questionnaire survey including around 65 % male and 35% female)

Table 5 : Quantification of environmental impact on various selected environmental parameters

Environmental Parameter	QEI ^a	(Wi)	Degree of Impact		Wi*(Vi) ₁	Wi*(Vi) ₂	NEQV
			(Vi) ₁	(Vi) ₂			
Physio-chemical parameters		250					
Surface water quality	S	60	-1	-4	-60	-240	-180
Ground water quality	VL	20	0	-1	0	-20	-20
Air pollution	M	40	0	-3	0	-120	-120
Noise pollution	VL	10	0	-1	0	-10	-10
Odour Pollution	M	50	0	-3	0	-150	-150
Climate Change	VL	10	0	-1	0	-10	-10
Regional hydrology & flooding	VL	10	0	-1	0	-10	-10
Ground water table	M	30	0	-3	0	-90	-90
Soil fertility	M	20	0	-3	0	-60	-60
Ecological parameters		200					

Fisheries	H	60	2	-4	120	-240	-360
Aquatic Biology	H	50	1	-4	50	-200	-250
Terrestrial flora & fauna	M	40	1	-3	40	-120	-160
Forest	M	20	2	-3	40	-60	-100
Wildlife	M	10	0	-3	0	-30	-30
Wetlands	M	20	0	-3	0	-60	-60
Human interested related parameters		550					
Employment opportunities	P	70	-1	4	-70	280	350
Commercial & service facilities	P	40	0	3	0	120	120
Industrial activities	H	10	0	-3	0	-30	-30
Agriculture	M	15	2	-3	30	-45	-75
Water Supply	P	25	0	3	0	75	75
Electricity and gas supply	P	25	0	3	0	75	75
Sewage and waste disposal	M	20	-1	-2	-20	-40	-20
Sanitation	M	10	-1	1	-10	10	20
Recreation	L	10	1	-2	10	-20	-30
Road & railway	P	10	0	3	0	30	30
Land use & land value	P	60	0	5	0	300	300
Socio-economis aspects	P	30	-2	3	-60	90	150
Resettlement	M	10	0	-2	0	-20	-20
Agriculture land loss	S	30	0	-5	0	-150	-150
Public Helth	L	10	0	-2	0	-20	-20
Parasitis Diseases	L	10	0	-2	0	-20	-20
Nutrition	L	10	1	-2	10	-20	-30
Public Safety	L	10	1	-1	10	-10	-20
Landscape	L	15	1	-1	15	-15	-30
Disposal of garbage	M	20	0	-4	0	-80	-80
Drainage congestion	S	40	0	-5	0	-200	-200
Slum Development	M	10	0	-3	0	-30	-30
Flood control	P	60	-4	3	-240	180	420
Total		1000			-135	-960	-825

Here, P=Positive impact; S=Severe negative impact; H=Higher negative impact; M=Moderate negative impact; L=Low negative impact; VL=Very low negative impact; QEI=Qualitative Environmental Impact. Wi=Relative importance value, $(Vi)_1$ =Degree of impact without urbanization, $(Vi)_2$ =Degree of impact with urbanization, Net environmental quality value (NEQV) = $Wi*(Vi)_2 - Wi*(Vi)_1$

IV. CONCLUSIONS

The DND area was originally a flood control, drainage and irrigation project but the development trend goes towards urbanization, i.e. the original objective has been totally changed. As urbanization is inevitable, immediate measures should be taken to create the area into a planned town as because the present trend is going on in an unplanned manner. From this study it is reveal that surface water pollution, air and noise pollution, odor pollution, soil fertility, fisheries, aquatic biology, terrestrial flora and fauna, drainage congestion, sewerage and waste disposal, poor sanitation, resettlement, agricultural land loss, public health, parasitic disease, public safety, and improper disposal of garbage etc. are most important environmental concerning factors for environmental degradation. However, there are some positive impacts due to urbanization which can be listed as: employment opportunities, land value, water supply, power/gas supply facilities, development of new industry, development of new road, and slight improvement of socio-economic condition. Our quantification efforts of

environmental quality value [see table 5] indicate that overall environmental quality in DND zone is highly degraded due to rapid unplanned urbanization.

There should be make a plan for the recycling and reclamation of waste is to be promoted for conservation of resources. The green belt and landscaping should be prepared as per master plan. There should be sufficient provision for both capital and O&M facility especially for road, sewerage system, treatment plant, solid waste management and for other utility services. To facilitate the development activities there should be a management organization responsible for getting approval for development plan and budget from higher authority, implementation of primary level of development work and monitoring private level development work. The environmental-monitoring program is necessary for monitoring of ambient environmental quality. Monitoring data should be compiled, analyzed and evaluation report is to be prepared for future reference and management decision.

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