

Urban-Industrial Expansion and Water Resources in Naihati Municipality, Barrackpore Sub-Division, North 24 Parganas, West Bengal

Dr Rimi Roy

Assistant Professor, Department of Geography, Vivekananda College, Madhyamgram, North 24 Parganas, India.

Abstract:

Background:

Urbanization as a structural process of change is generally related to the concentration of large-scale and small scale industrial and commercial, financial and administrative set up in the cities (Newman, 2011). Accelerated urbanization and industrialization are two of the main processes responsible for increased pressure and deterioration of water resources. Naihati Municipality in Barrackpore Sub division is highly urbanized area and the population pressure is also very high which affects the quality and also quantity of ground water sources. The people of this municipality depend on the underground water sources for their daily domestic water use and also drinking purposes.

Besides, due to the rapid growth of industrialization mainly, different small and medium scales industries the whole required water withdrawals from the underground water sources. This study reveals the affects of urban industrial expansion on water resources both the ground water and also the surface water sources.

Materials and Methods:

Naihati Municipality has a strong industrial background and a huge population pressure, to understand the present situation of water sources both the surface and ground water source so this study consist both the Primary survey (including GPS survey) and secondary data collections methods. Primary data were collected through household survey by interview (face to face) method and the secondary data was collected from different secondary sources like Barrackpore Subdivision Office, Naihati Municipality, District Census hand book and Census of India. All the collected data were tabulated and computed through MS word 2007 and MS Excel for constructing different charts and diagrams by using various cartographic techniques. Maps are prepared through (QGIS, Arc GIS) open source software.

Results:

In the Naihati Municipality there are 31 no of wards with a density of population 18891 person/sq km (2011). Due to the urban growth and also industrial development a high water demand is noticed here. But the municipal water supply does not satisfy this high demand of water among the urban people and create a negative water balance. Besides, the only water source is from underground water so naturally the ground water levels decline day by day. This study represents the above scenario of Naihati Municipality and introduced some possible suggestions and recommendations.

Conclusion:

From the study it is identified that urbanization is highly related the industrialization and also modernization. A rapid growth of industrialization and increasing population are the two main features in this municipality along the bank of the river Hugly, for easy availability of water and transport.

Key Words: Industrialization, Urbanization, water demand and supply, Ground water, Water balance.

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I. INTRODUCTION

Naihati is a town and an important railway junction station of the Indian Railways network, in the district of North 24 Parganas, West Bengal. Naihati Municipality is one of the oldest in the whole country as it was established in 1869. The industrial development started in this municipality before Independence of India. Large scale industries are concentrated along the bank of the River Hugli. The urban growth is rapid in this study area and, a huge volume of labour force is available here. The industrial and urban water sources are the underground water storage. With the huge demand of water in both urban and industrial sectors, the ground water level has been decreasing significantly.

II. MATERIAL AND METHODS

Study Design:

The study was based on both the Primary survey and Secondary survey. Primary survey consists of 30 no of industries in different categories and 300 households through questionnaire survey. The water demand of each industry and the water sources of industries were identified. Besides, the population growth, density and water demand have noticed through primary survey. From the secondary sources, the decadal growth of population and industrial development here revealed. The ground water depletion negative balance of water is seen. Different maps and charts are prepared for supporting the above social problems.

Study Location:

It is located at 22°55'N to 22°52'N of latitudes and 88°24'E to 88°26'E of longitudes. It has an average elevation of 15 m from the mean sea level. From the year 1971 to 1995 the total area of this municipality was 4.35 Sq. Km. In 1995, three Gram Panchayats, namely Rishi Bankim Gram Panchayat, Deshbandhu Uttar Gram Panchayat and Deshbandhu Dakshim Gram Panchayat were added to this municipal town. In 2001, the total area of this municipality became 11.35 Sq. Km. bounded by 'Bagher *Khal*' in the north to 'Ichapore *Khal*' in south. According to Census of India 2001, it comprised 28 wards on the both sides of Naihati Railway Station; but now it has 31 numbers of wards.

Study Duration: 12months (January 2011 to January 2012)

Sample size: 30 no of different categories of industries are chosen from different wards in this municipality for GPS survey and 300 household were chosen from different wards in this municipality for primary survey.

Sample size calculation:

30 no of industrial data by (GPS survey) are tabulate and plotted on Naihati municipality administrative map. Besides, random sample techniques are applied for primary data collections (300 household surveys) and different diagram preparation.

Subjects & selection method:

The rapid growth of urbanisation and industrial development affect the water sources both the surface water and underground water. Naihati Municipality has been selected for intensive study and to fine the macro level impact on water resources due to the population growth and industrial development.

Procedure methodology

Primary sample survey has been conducted for the co-ordinate location of industries is identified through GPS (Global Positioning System, Model: Etrex Vista HCx) survey. All the industries of Naihati Municipality are dependent for their required water from underground water sources. Primary surveys have been done to measure the water demand of each category of the industries. On the basis of the secondary data and also the primary data, the water balance is calculated in industrial sectors in the urban areas and the amount of water deficit to identify the water crisis zones through the surface water potentiality map, which is prepared by taking into account Land use and Land cover (LULC) map, 2010. Due to the rapid growth of urbanization, population increased rapidly in this municipality. The decadal population data during 1971 and 2011 are collected from 'Census of India' and the growth rate of population of decades are calculated and represented through different cartograms.

Demographic features like total population growth, degree of urbanization, density of population etc. have been taken as major indicators. Data have been collected from the 'District Census Hand Books'; Government of West Bengal, for the period 1971 and 2011 and primary household survey have been conducted through random sampling. Different maps on the expansion of urbanization are prepared through GIS and remote sensing software (Arc GIS, Version 10 and TNT Mips, Basic-2012). A large number of people of Naihati Municipality depend for their drinking and domestic water on underground water sources. The data of seasonal ground water table are collected from the different wards in this municipality, Central Ground Water Board (ER), Kolkata and also from the primary sources. The maps of fluctuation of ground water level are prepared season wise (January to June and July to December) using GIS software for the years 2011.

Statistical analysis

The maps of fluctuation of ground water level are prepared season wise (January to June and July to December) using GIS software for the years 2001 and 2011. The amount of supply of water per day, per capita is collected from Naihati Municipality office. On the basis of these data per capita water demand is calculated through the following formula:

Per capita water demand= $Q / (P \times 365)$ liters /day

Where Q= total quantity of water required, P= Population

Depending upon the computed values of average annual water demand, average daily water demand and average community daily water demand for the year 2001 and 2011 are calculated by “small system method” and represented through different cartograms.

Average community daily water demand = Average daily water demand × Number of people

Different cartograms are prepared to show the balance between daily water demand and supply. At present, it is observed that the demand of water is more than the supply, and water stressed situation has arisen in villages and some municipalities. Wetness index map is prepared to identify the surface water potentiality of the study area.

III. RESULT

Industrial Development and Waste Water

Before the Independence of India, the major industry of Naihati Municipality was jute. Basically, the economy of the town was depended mainly upon jute industries. But, now the jute industrial plants have been closed down and many small and medium scales industries have grown up. Previously, there was an abundant supply of laborers, ample coal for power and the huge water from the Hugli River. Jute industry of Naihati Municipality was self-sufficient with regard to the supply of raw jute. Five registered jute mills started their journey before 1950s. Besides, rubber and cotton textile industries also were established during this time. With the Partition of Bengal, most of the jute growing areas went to East Pakistan (now Bangladesh) and a few remained in West Bengal. The jute industries were closed mainly due to the pressure of the changing market economy. The necessary diversification was not made and updated machinery was not installed, leading to the erosion of market for the product. Three jute industries out of five are now closed. These are: Nudda Jute Mill, Guipure Jute Mills, Jenson and Nicholson Pvt. Limited.

The medium and small scale industries like printing, chemical, cotton, *biri* making, cement, leather, rubber, horticulture are developed rapidly with an availability of plenty of labour forces. The principal industrial units include: Shaw Rubber Company, Chowdhury Printing Pvt. Ltd., Naihati Scrap Pvt.Ltd, Max Life Sales Pvt. Ltd, K.M. Factory, Enviro Engineers, etc. Moreover, many brick fields are situated on the Hugli River bank.

Name of the industry	Units	Employment	Percentage
Engineering	3	810	2.50
Jute	10	3512	10.86
Plastic Based	11	1571	4.86
Chemical Based	13	1120	3.46
Rubber Based	21	621	1.90
Ceramic/Brick field	9	200	0.61
S.S.I	58	15288	47.29
Printing	36	6512	20.14
Others	72	2689	8.32
Total	233	32,323	100.00

Table-1: Categories of industries and employment status in Naihati Municipality, Source: Naihati Municipality, 2011

The total number of industrial units in Naihati Municipality is now 233. Most of the industries are concentrated along the right bank of the River Hugli. The maximum number of industries is found in others category (72) of industries, whereas engineering (3) industry occupies the minimum number of industries (Table-1). The total number of industrial workers is 32323 persons. The highest work participation of population is recorded in small scale industries (47.29%), whereas the lowest work participation is in Ceramic/Brick field (.61%).

Primary Sample Survey of Industries

Primary data of the different categories of industries have been collected GPS survey. Thirty industrial units have been selected for sample survey on the basis of industrial agglomeration. Most of the large scale

industries, mainly jute industries, are concentrated beside the right bank of the River Hugli. Medium and small scale industries are situated slatternly in every wards of Naihati Municipality.

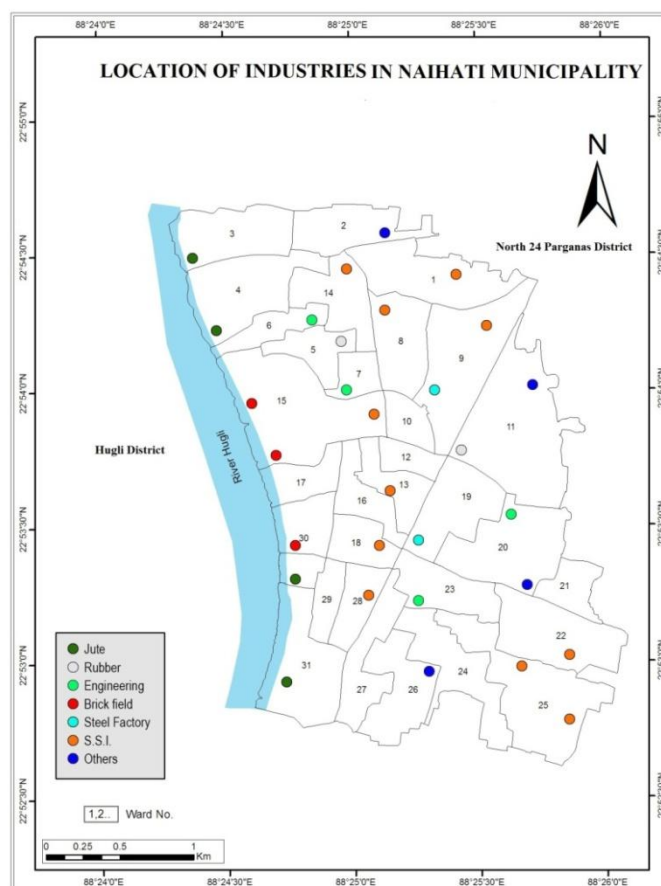


Figure-1: Primary Survey using GPS, 2012 conducted by the researcher

Figure: 1 represents the primary samples survey of 30 industrial units in different wards of Naihati municipality in 2012. The categories of industries are Jute, Rubber, Engineering, Brick field, Steel factory, S.S.I and others. The number of industries is Jute-4, Rubber-2, Engineering-4, Brick field-3, Steel factory-2, S.S.I-11 and others-4.

Industrial Water Issues

Before Independence, the large scale industries mainly jute mills in Naihati municipality were established beside the right bank of the River Hugli for easy availability of required water. But, at present the maximum numbers of jute mills are locked out and rest of the jute mills do not have sufficient capacity to purify the surface water of the River Hugli for their requirement. Gradually, all the industries of the river bank are depended for their required water on underground sources. As a result, the level of ground water has been decreasing rapidly and at the same time, industrial waste water pollutes the surface water bodies to a great extent.

Sources	No. of industrial units	Percentage of the total
Direct Ground water	21	70.00
Surface water	2	6.66
deep tube wells	5	16.66
Piped water	2	6.66
Total	30	100.00

Table-2: Industrial water sources in Naihati Municipality, Source: Primary Sample Survey, 2012

The maximum numbers of industrial units collect water from direct ground water (70%) sources, whereas the deep tube wells and piped water sources are utilized only 16.66% and 6.66% of industrial units (Table-2). The surface water source (6.66%) is used mainly for large scale industries in this study area.

Categories of industries	Average daily water demand (liters/day)
Jute	3850
Rubber	400
Engineering	350
Brick field	450
Steel factory	1000
S.S.I	550
Others	600

Table-3: Average daily water demand in the different industries, 2012, Data Source: Primary Sample Survey, 2012

The maximum water demand is found in jute industries (3850 liters/day) and the minimum in engineering industries (350 liters/ day). Moreover, rubber industries, brick field, steel factory, S.S.I and others industries have the water demand of 400 liters/ day, 450 liters/ day, 1000litres /day, 550 liters /day and 600 liters / day respectively (Table-3). In case of S.S.I industries average daily water demand is fluctuated seasonally.

Outlet system	No. of industrial units	Percentage of the total
River	11	36.66
Surface Water Bodies	9	30.00
Main drain	7	23.33
Depressed ground	3	10.00
Total	30	100.00

Table-4: Industrial waste water outlets, 2012, Source: Primary Sample Survey, 2012

The different types of industrial units surveyed have been found to release their waste water through different outlets. Table-4 represents four types of waste water outlets such as river, surface water bodies, main drain and depressed ground. The maximum number of industries (36.66%) discharge their waste water in the River Hugli and the minimum number (10%) of the industries discharge their waste water in depressed ground. 30% of industries discharge their waste water in surface water bodies and 23.33% of industrial waste water are passing through main drains. In this situation, water recycle process is necessary for avoiding water pollution. Primary sample survey has been done to identify the number of industrial units which have the waste water recycle system.

Recycling process	Number of Industrial units	Percentage of the total
Yes	3	10
No	27	90
Total	30	100

Table-5: Number of industries having recycle process or not, 2012, Source: Primary Sample Survey, 2012

Only 10% of industrial units mainly large scale industries, have the recycling system but the rest of the sampled industrial units (90%) do not have any recycling process. The total amount of waste water is released either on surface water bodies or passes through the pipe lines.

Urban Population Growth and Expansion in Naihati Municipality

As of 2011 census, Naihati Municipality had a population of 218194 persons, and it ranked 50th populated city in the world. The jute mills drew a large labour force from the neighboring states of Bihar and Orissa (now Odisha) as well as eastern Uttar Pradesh. They form an overwhelming majority of the population in

the area and live in slums and squatters near the jute mill areas. Many of the East Bengal refugees came to settle mostly in the squatters and colonies of Naihati Municipality. Figure-2 represents the total population in 31 wards of Naihati municipality from 1971 to 2011. Before 2001, the total number of wards was 19 and from the year 2001, the total number of wards increased into 31. The area of this municipality also increased by 165.52 percent, as three villages was included in 1995.

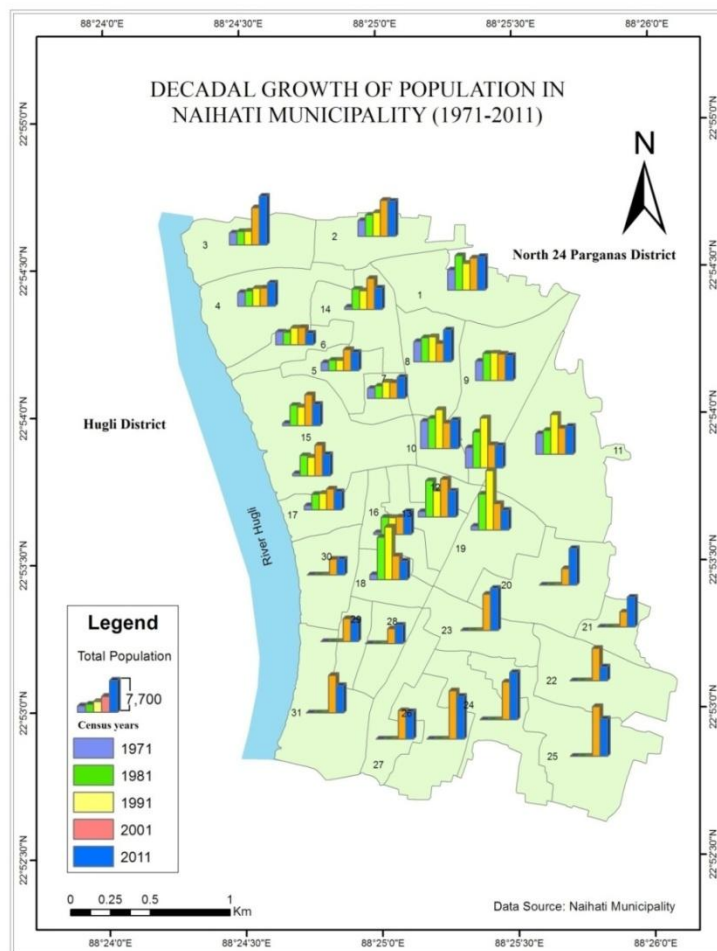


Figure-2: Prepared by the researcher based on Census of India data, 1971-2011

In the year 1971 the highest population was reached in Ward No. 10 (7059 persons) and the lowest one in Ward No. 16 (485 persons). But in 1981 and 1991 the highest population was note in Ward No. 18 (10998 persons) and 19 (15340 persons) respectively, but the lowest population was in Ward No. 5 (2726 persons) and 5 (2720 persons). This total population is considered into 19 no of wards of this municipality.

Year	Pop Density
1971	7106
1981	9922
1991	11489
2001	18643
2011	18891

Tabel-6: Density of population in Naihati Municipality, Census-1971-2011

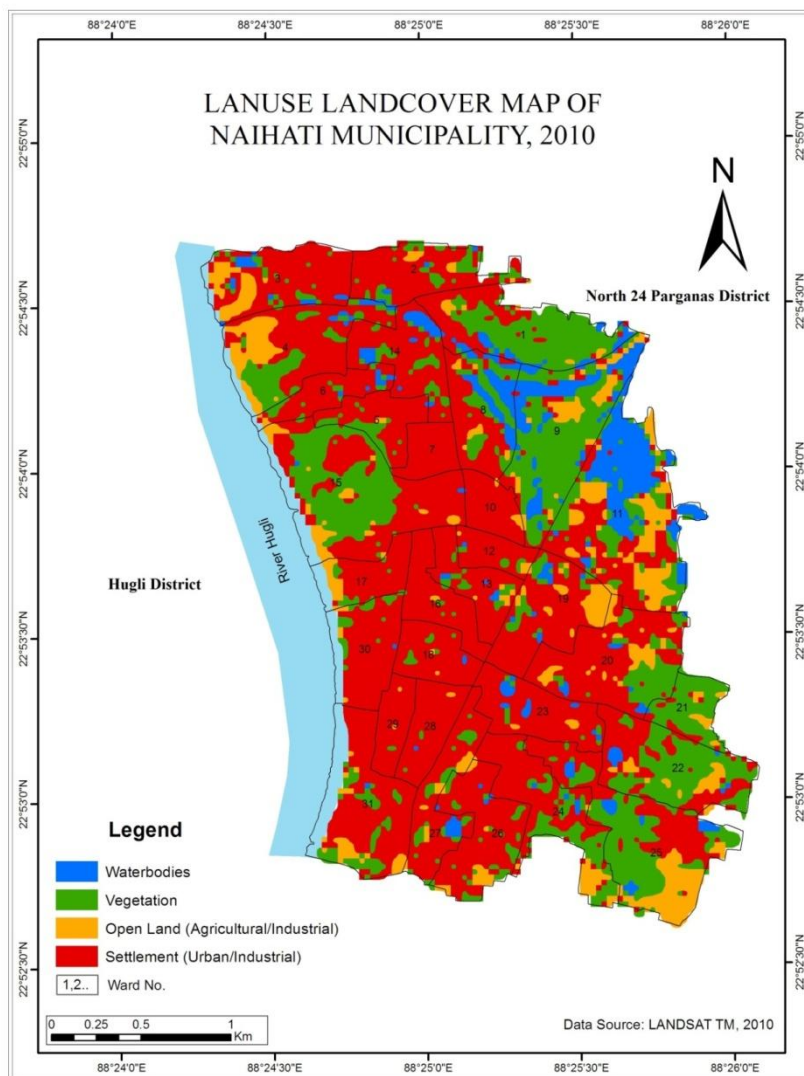


Figure-3: Source: LANDSAT TM, 2010

Figure-3 represents the land use pattern of Naihati Municipality for the year 2010. The large natural water bodies are concentrated mainly in Ward No. 4, 8, 9 and 11. Some small water bodies are located mainly in Ward No. 14, 3, 4, 23, 20, 19 and 27. Water bodies occupy only 0.57 sq km of the total municipal area and the maximum area of the municipality is occupied by settlement and industries.

Primary Sample Survey of Urban Population

Primary sample study has been done to include 1378 population of which male population is 799 (58%) and the female population is 578 (42%). All the surveyed households (300) exhibit more male population than the female.

Income group	Income	Expenditure
Very low	25	91
Low	88	72
Medium	95	70
Medium high	47	37
High	25	20
Very high	20	10
Total	300	300

Table-7: Income and Expenditure pattern (in Rs per month) in Naihati Municipal area, Primary Sample Survey, 2012

The amount of income and expenditure of the different households are collected through primary sample survey of 300 households. The income and expenditure have been classified into six categories, such as; very low (less than Rs.5000), low (Rs.5000-10000), moderate (Rs.10000-15000), moderate high (Rs.15000-20000), high (Rs.20000-25000) and very high (Rs.above 25000) per month (table-7). The maximum number of families lie in medium income group (95) and the minimum number of families lies in high income group (20) whereas, the maximum number of families lie in low expenditure group (91) and minimum number of families lie in high expenditure group (10). Thus the economic status of the study area is not very bad industrial development is high in this area.

Urban Water Issues in Naihati Municipality

In Naihati Municipality, the main domestic water source is underground water. The municipality supplies the domestic water through pipe lines of various diameters from the over head reservoirs/ tanks.

Income Group (in Rs.)	Water Demand (in litre)
< 5000	80
5000-10,000	85
10,000-15,000	90
15,000-20,000	100
20,000-25,000	120
> 25,000	170

Table-8: Relation between income group and per capita daily water demand, 2012, Data Source: Primary Sample Survey, 2012

Table-8 reveals the categories of income group and the per capita daily water demand. It is identified that the high income group people have the high level of water demand as their standard of living is usually high. Here the very high income group (above 25,000) obtains the highest amount of water demand (170 liters per capita per day) and the very low income group (less than 5000) is found to demand comparatively low amount of water (80 liters per capita per day). Thus income of household has a good positive relation with water demand.

Drinking water source	No. of families	Percentage of the total
Hand Pumps	20	6.66
Piped water (through pump)	247	82.34
Deep tube wells	32	10.66
Pond /Jhill	1	0.33
Total	300	100.00

Table-9: Different sources of drinking water, 2012, Primary Sample Survey, 2012

Two types of tap connections are found in Naihati Municipality in the primary sample survey. These are multiple tap connection and single tap connection. 32.66% of the households have the multiple tap connection and 60% of households occupy the single tap connection. Mainly the high income group of people uses the multiple tap connection. But 7.34% of households have no tap connection. It is also found that 66% of households perceive that domestic water purification system is needed but 34% of households state that the domestic water purification is not needed. In this context, 67.33% of households have obtained the water purification system but 32.66% of households do not use the water purifier.

Domestic waste water outlet	No. of families	Percentage of the total
Pipe lines to Main drain	85	28.33
Sub drain to main drains	180	60.00
Pond / jhill	35	11.66

Total	300	100.00
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Table-10: Domestic waste water out lets, Primary Sample Survey, 2012

From the primary sample survey, four types of domestic waste water out lets have been identified such as Pipe lines to main drain, sub drain to main drain, pond/ Jhill (table-10). The maximum domestic waste water is released through sub-drains to main drain (60%) and the minimum domestic waste water is discharged directly into pond/ jhill (26.66%). However, 28.33% of domestic waste water is going through pipe lines to main drain. It is clear that domestic waste water pollutes the surface water sources; because 62.33% of households state that domestic waste water pollute the surface water sources. But 37.66% of households state that this water does not pollute the surface water sources. Primary perception survey has also been done to identify within the supplies water is adequate or not. 44% of households states that the water supply is adequate for their domestic purposes, but 56% of households states that they do not get the required amount of water for domestic use.

Water Balance in Naihati Municipality

The main water supply system in Naihati Municipality is the piped water from underground sources through different pumps and over head reservoirs of various capacities. The total water supply is 3.5 million litres/ day. The total population in 2011 is 218194 persons and the average community daily water demand is calculated to be 3.7 million liters per day. As a result, the water balance is a deficit of -2.09 million litres per day (Table-11).

Total water supply (liters/ day)	Per capita water demand (liters/day)	Population 2011	Average community daily water demand (liters/day)	Water balance (liters/day)
35000000	170	218194	37092980	-2092980

Table-11: Water balance in Naihati municipality, Source: Naihati Municipality, 2011

IV. Discussion

Water Issues in Naihati Municipality

The main source of water for domestic and commercial purposes in this municipality is the underground water sources. The total volume of ground water used for industrial sector is estimated to be 500 million litres/day. As a consequence, the level of ground water is decreasing day by day.

The size of urban population is quite high in this municipality. The huge urban population use ground water as their domestic and drinking water purposes. There are 480 numbers of tube wells, 1000 number of street taps, 28 numbers of deep tube wells, and 47 numbers of pumping stations for supplying the water to the houses (Naihati Municipality, 2011). The water supply system of the municipality consist of different types of pipe lines and over head reservoirs such as; three types of pipe lines (C.I pipe, A.J pipe, D.J pipe), OH tank by municipality, OH tank by KMWSA, OH tanks by railway, pump houses by municipality and pump houses by KMWSA. Map-8.5 represents the location of these six types of water supply sources. There are 8 OH pumps out of which 5 have been constructed by the municipality, 1 by KMWSA and 2 by the railway authority. Moreover, the total number of pump houses is 39 out of which 31 are constructed by the municipality and 8 by KMWSA.

Water Force	No. of households	Percent of the total
High	120	40
Medium	105	35
Low	75	25
Total	300	100

Table-12: Status of water forces of the municipal supply, Primary Sample Survey, 2012

It is observed that the supplied water force in Naihati Municipality varies among the different households (Table-12). The high water force contains 40% of households and the low water force contains 25% of households and medium water force is observed in 35% of the households.

Water quality	No. of household	Percentage of the households
Bad	15	5
Good	160	33.33
Moderate	108	36
Very bad	17	5.66
Total	300	100

Table-13: Quality of domestic water in Naihati Municipality, Data Source: Primary Sample Survey, 2012

The quality of domestic water varies in the different households (table-8.24) 5% and 5.66% of households get bad and very bad quality of water whereas 33.33% and 36% of households get good and moderate quality of water.

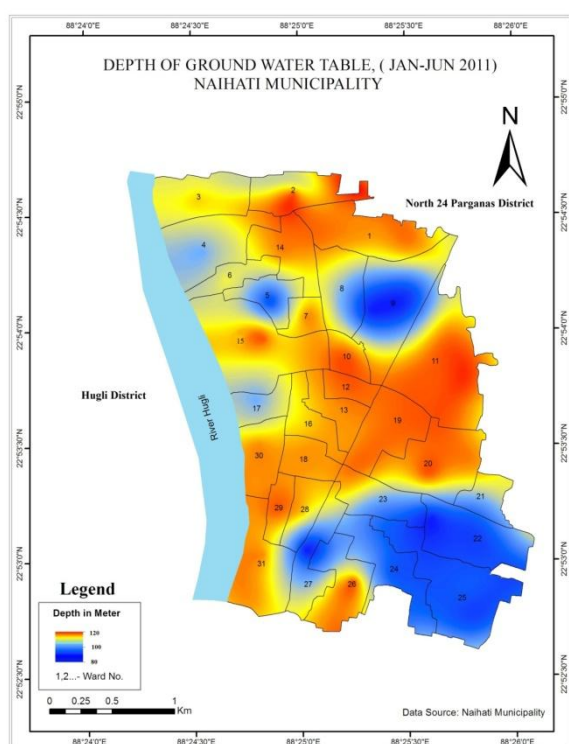


Figure-4: Ground water table (Jan-June, 2011)

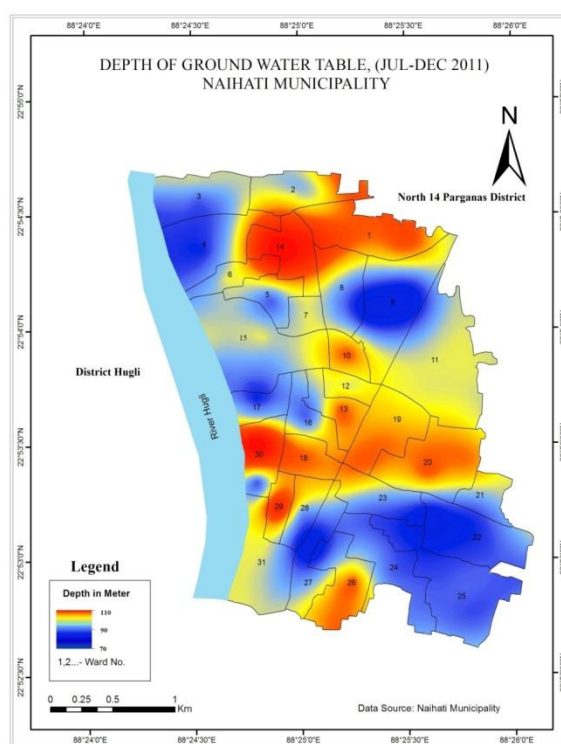


Figure-5: Ground water table (July-Dec, 2011)

Due to the rapid growth of urbanization and industrialization the ground water level decreases rapidly. The main source of domestic and industrial water is the underground water. Every day a huge volume of water is withdrawn from the under-ground sources. Figure-4 represents zones of depletion of ground water level from January to June in 2011. The maximum depletion (120m from the surface) is located in north (Ward No. 2, 14 and 1), middle (Ward No.10, 11, 12, 13, 19, 18, 29 and 30) and south west parts of the study area (Ward No.31, 26 and 28) and the minimum depletion (80m from the surface) is located in north east (Ward No.8 and 9) and south east (ward no-22, 23, 24 and 25) parts of the study area. Figure-5 represents zones of depletion of ground water level from July to December in 2011. The maximum depletion (110m from the surface) is found in north (Ward No.14 and 1), middle (Ward No.10, 13, 19, 18 and 29) and south west (Ward No.26) parts of the study area and the minimum depletion (70m from the surface) is located in north west (Ward No. 3 and 4) and south east (Ward No.22, 23, 24 and 25) parts of the study area.

V. SUGGESTION AND RECOMMENDATIONS

- 1) New water treatment plants which is situated near the Naihati Municipality should be set up to reduce the over use of underground water sources. The proposed surface water treatment plant should be constructed in Titagarh municipality ward No 10 near the bank of the River Hugli. Besides, artificial recharge of ground water should be introduced.
- 2) In this municipality the growth of population increases rapidly in several decades. There should be some positive development guidelines regarding urban growth, so that the new growth may be directed and channelized to appropriate locations in appropriate forms.
- 3) The municipal water supply systems should be improved for adequate supply of water. More pump houses, overhead reservoirs should be built with extra capacity of storage of water. New connections of tap water must be increased in every household. The length of pipe lines should be extended for adequate supply of water.
- 4) To avoid the misuse of domestic and industrial water, the water pricing may introduced taking into the consideration the socio-economic condition of the people and willingness to pay for water. The introduction of water charges will be considered after proper water supply system in the whole Sub-division. While laying the charges, the interest of urban poor shall be safe guarded. To measure the uses of domestic water, water meters should be introduced at household, factory and all commercial and government institutions.
- 5) Rain water harvesting practices is to be introduced to store rain water for reuse before it reaches the aquifer. Rain water harvesting has to be promoted particularly in urban areas, as a technological solution that can be adopted by all. In a roof top rain water harvesting system should be introduced where water collected from roof catchments usually must be of acceptable quantity for domestic purposes.

VI. CONCLUSION

In Naihati Municipality, the industrial development is rapid in case of jute, engineering, S.S.I and other industries. From the primary sample survey, it is found that the industrial waste pollutes the surface water bodies in various manners. The only source of industrial water is underground water. As a result, the ground water level decreases rapidly. Besides, the urban population growth rate is high in this municipality. The domestic water demand does not fulfil by the total water supply system as a whole, and water crisis is arisen in spite of the presence of the River Hugli in the area. With the high demand of domestic water, a huge volume of water is withdrawn from the underground water sources. As a result, ground water depletion increases rapidly.

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