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Analysis of Urban Growth and its Impact on Environmental Resources: A case study of Haldia Urban Area in West Bengal.

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Abstract:

Being a growing economic growth centre rapid urbanization takes place at Haldia and it has become an important industrial urban center of West Bengal. Rapidly increasing population and resultant anthropogenic activities have forced the area to undergo through continuous transition, disrupting the urban morphology and creating enormous pressure on resource base. The main purpose of the present study is to analyse the growth of urbanization and its profound impacts on environmental resources. In this paperan attempt has also been made to detect the changes in the land use and land cover (LULC) from the Landsat imageries of Haldia municipality. The study focuses on urban-environment conflicts escalating the vulnerability of the area. Moreover, demographic changes due to rural push and urbanpull factors have been reflected in this study. Finally, on the basis of the findings a future road map for planned urbanization balancing ecology, industry and livelihood has been set forth.

Keywords: Growth centre**,** Urban morphology, Environmental resources, Land use and land cover, Demography, Vulnerability.

1. Introduction:

Due to industrialization and concentration of other economic activities urbanization takes Place rapidly in Haldia In search of better social and economic opportunities people from rural areas are attracted towards the urban. As a result the city extends rapidly at the periphery and the city outskirts. This leads to permanent change of land cover of an area with increasing built up density. Simultaneously the unplanned urbanization affects adversely the environment and natural functioning of eco-system and environment (Turner, 1994). Haldia urban area has subsequently developed with the establishment of a satellite port of Kolkata port in the early 1970s to reduce the increasing pressure on Kolkata port and became an industrial township

taking locational advantages and other favorable facilities. Rapid urbanization and industrialization put tremendous pressure on existing resources, infrastructure and environment (Mukhopadhyay & Das, 2015). The negative impacts noted are transformation of agricultural land, loss of habitat, air pollution, unemployment, accumulation of urban waste, disturbance in aquatic ecosystem etc.

Haldia is the largest town in the district of Purba Medinipur, West Bengal and experiences an intense level of urban development. In the last three decades urbanization has taken rapid strides in Haldia urban area due to massive industrialization and growth of other economic activities. This urban industrialization has detoriated the environmental quality of water bodies, loss of fishes and wildlife habitats. Such impacts have reduced the local capacity of lands to support both ecosystem and human enterprises at large scale.

To address these problems an effort has been made here to put environmental perspective in to land use planning and decision making processes effectively. If environmental resources are ignored while accommodating this kind of growth, more environmentally sensitive areas will be lost. Therefore, the present study has tried to analyze the degree of urban growth and to assess the effects of urbanization largely on environmental resources and local environmental problems as well. The GIS database and Census data have been used to evaluate the extent of urban growth and its effects on the immediate environment which in turn would help to identify the probable road for the recovery.

The continuation of urbanization pattern increases land and resource consumption, and exacerbate the environmental problems. Therefore, a systematic planning along with a road map involving planners, governments, planning agencies and others is very much necessary in order to address these problems immediately and put environmental perspective into land use planning and decision making process effectively and promptly.

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2. Location of the Study area:

Haldia is one of the fastest growing industrial towns of West Bengal emerged as a municipality in 9th June, 1997 with the areal coverage of 109.89 sq.km. The town extends from 22°00'52.98" N to 22°08'35.76" N latitude, and 88°04' E to 88°11' E longitude. Haldia is located at the confluence of two rivers namely Hugli and Haldi in the district Purba Medinipur. The port city is at a distance of 125 km south-west of Kolkata and 50 km upstream the Bay of Benga The town is wel connected with the National Highway (NH-41) connecting the township with the Kolkata-Mumbai National highway(NH-6) at Kolaghat. According to 2011 census report, the total population of Haldia Municipality was 2, 00,827 with the density of 1,912 persons/ km^2.The male population constitutes of 53% and female is 47%. There are 29wards in Haldia Municipality after 2015 but in this study 26 wards have been counted due to the availability of data (census data).

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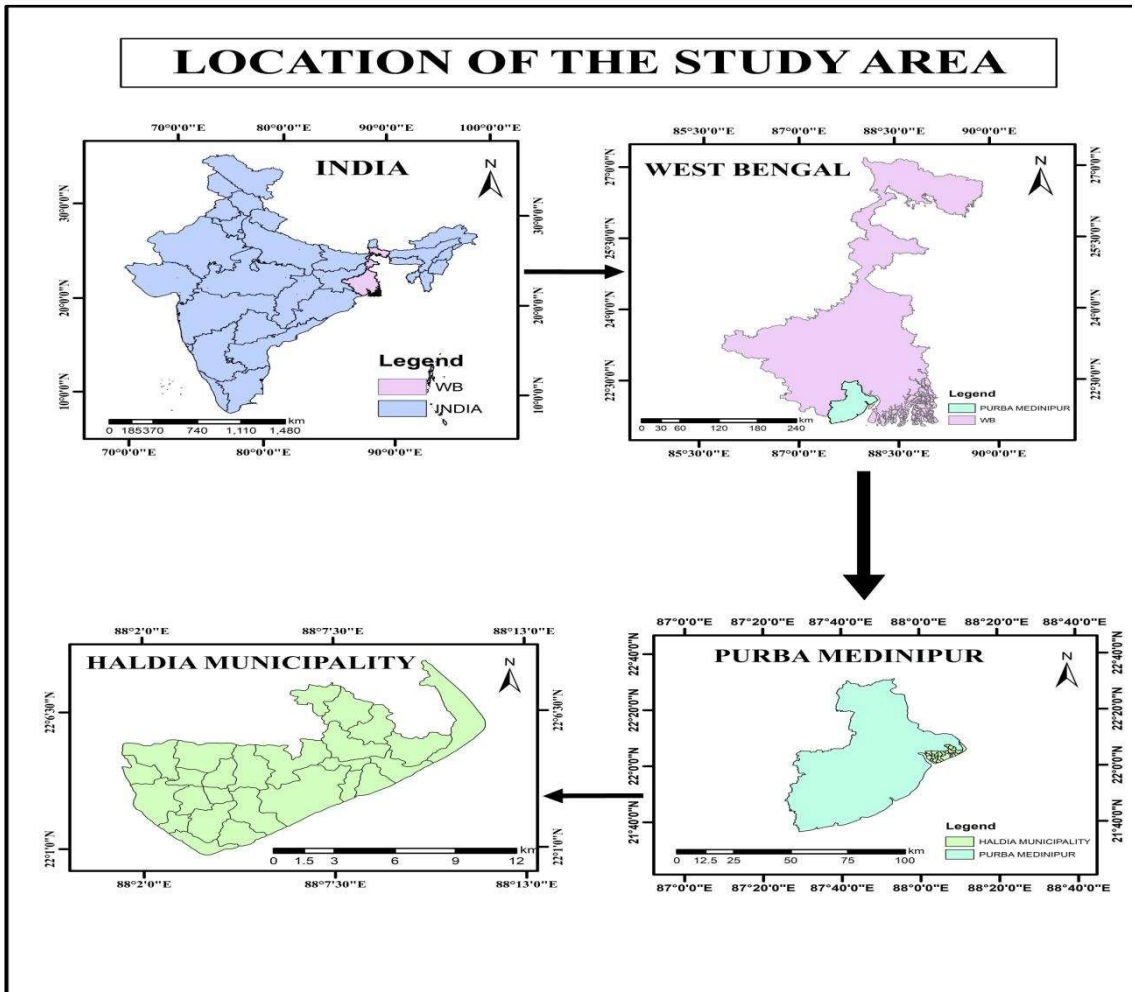

Figure - 1: Location of the study area (Haldia Municipality)

3. Objectives of the study:

The main objectives of the studyare -

i) To analyze the growth of urban area and perspective changesof population of the area.

ii) To study the temporal growth of industries and itsrelation with urban changes.

iii) To study the impact of urbanization on environmental resources.

iv) To propose land use planning strategies to avoid or at least minimize the impacts from future land use planning and decision makes process.

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4. Materials and Methods:

The strategy of the present study involves two methods - first is the review of literature (books, journal articles) and professional reports from various governmental and non-governmental agencies and second is the use of GIS as a tool to exhibit the urban growth and analyze the impact of urbanization on environment in Haldia urban area. Additionally, the author incorporates knowledge about urbanization, land use and environment based on his work experiences, research works he has done, and interactions with experts.

The whole study is based on both qualitative and quantitative analysis. Some fundamental statistical methods have been used to analyze the data relating to urban growth in relation with the temporal changes of population in order to achieve the objectives properly.

A very simple and straightforward method has been used to analyze the impacts of urbanization on environmental resources in Haldia urban area. It includes the (a) identification of environmental factors, (b) collection of required data, and (c) spatial analysis of the data using Arc GIS. Land sat satellite imageries of 2000 and 2016 as input database downloaded from the official website of the United States Geological Survey (USGS) Earth Explorer (http://earthexplorer.usgs.gov/).Ward wise map of Haldia municipality collected from the municipal authority has been used. High resolution Google earth imagery of Haldia -2016 has been used and Ground Control Point (GCP) by GPS survey has directly been collected from the field.

Some geographical techniques have been used for finding out changes, concentration and relational aspects of the study. In the present study land sat images over a period of time 2000, 2011 and 2020 have been collected and used. For data analysis the related secondary data are collected from different official sources like official website of Haldia Development Authority (HDA), Haldia Municipality, Pollution Control Board, District Census Handbook (of 2001 and 2011), district statistical Hand book and from different published journals and books etc.

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5. Result analysis and discussion:

Growth of urbanization in Haldia is basically the output of two processes - economic growth and town growth with the spatial location and relocation of human population, resources, and industries in that landscape. Rostow asserted that visible ecological linkages can be promoted through diffusion of habitat and activities based on economic functioning and administrative activities. Here diffusion of habitat and activities refers to the consumption of land for industrial activities, administrative divisions, new housing units and expansion of other infrastructures. The natural components of ecosystems are environmental resources from which an array of benefits can be generated and used for human consumptions. Some of the resources that are fundamental to the natural balance of the ecosystem and in the mean time that are subject to human intrusion are soil, water and biodiversity.

Population growth, increasing trend of urbanization, and land use and climate change has affected water availability and quality. Urbanization alters habitat through housing, road construction, pavement, devegetation, plantation of non-native species, land fragmentation etc. Residential development associated with expansion of roads, utilities etc. poses threat to wildlife through loss, degradation, and fragmentation of habitat. Alteration from urbanization is so drastic and widespread that it results in the endangerment and extinction of species accompanied by long lasting habitat loss. Apart from reducing the richness of native species, urbanization increases the dominance of nonnative species in the area thereby causing biological homogenization.

Changing demographic status of an area is one of the important indicators of the growth of urban center that includes various characteristics of population like total number, density, literacy, occupational structure and other socioeconomic details. The census data of years 2001 and 2011 is considered for the demographic analysis of the study area as the Municipality was established in 1997.

Table 1: Change of population of Haldia Municipality, 1971-2011

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Year	% of urban to total population	% change of urban population	Population of Haldia municipality	Degree of urbanization	Rate of change
1971	1.56	0	9968	Low	--
1981	2.93	1.38	21122	Low	Low Positive
1991	12.55	9.62	100347	Moderate	Highly Positive
2001	20.93	8.38	171673	High	Positive
2011	20.92	-0.01	200827	High	Negative

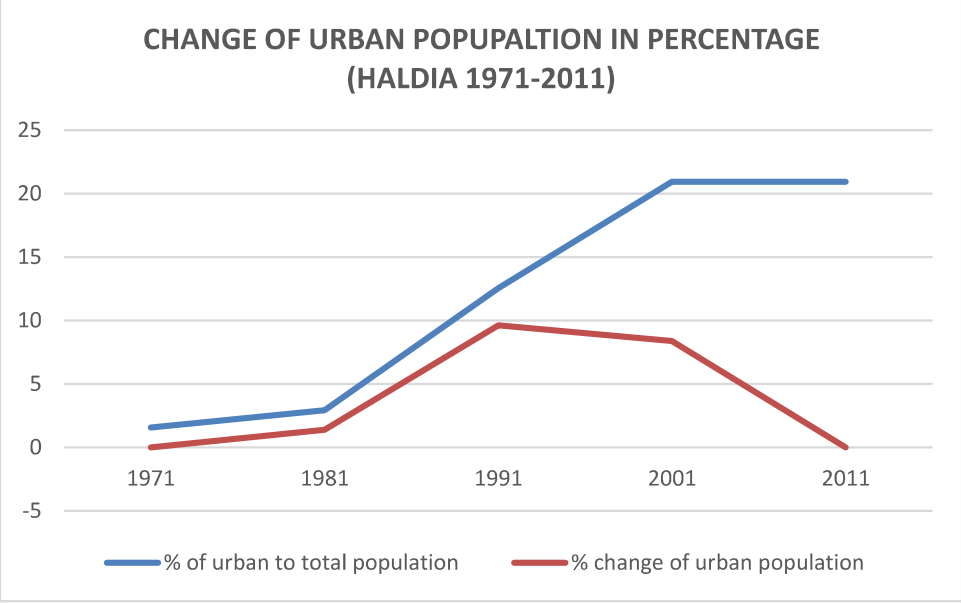

Figure No: 2 Change of Haldia's Urban Population in Percentage.

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Table 2: Percentage changes of area, population and density of Haldia Municipality, 1971-2011

Year	% OF AREA	% OF Population	% Change of density	Area(sq. Km)	Population	Density/sq.km
1971	6.71	1.98	6.92	21.6	9968	461.48
1981	5.04	4.2	19.51	16.2	21122	1303.83
1991	21.48	19.91	21.73	69.1	100347	1452.2
2001	32.61	34.06	24.49	104.9	171673	1636.54
2011	34.16	39.85	27.35	109.89	200827	1827.53
	100.00	**100**	**100**	**321.69**	**503937**	**6681.58**

Source: Census of Purba Medinipur, 2001-2011

Due to changing economic scenario distribution of population in Haldia urban area has been changed over time. After 1991 huge job opportunities were created with the establishment of different industries under government and private investment and entrepreneurships that attracted huge number of people resulted increase of population and subsequent urban growth. In 2001 total number of population was 170673 which has increased to 200827 in 2011 and the municipal area has increased from 104.9 sq. km to 109.89 sq. km in 2011. From the data it is revealed that population has increased in maximum wards during the period from 2001 to 2011 except ward no-7,13,16,17,19 and 21. However the highest number of population is found in ward no-9 and lowest in ward no-17.

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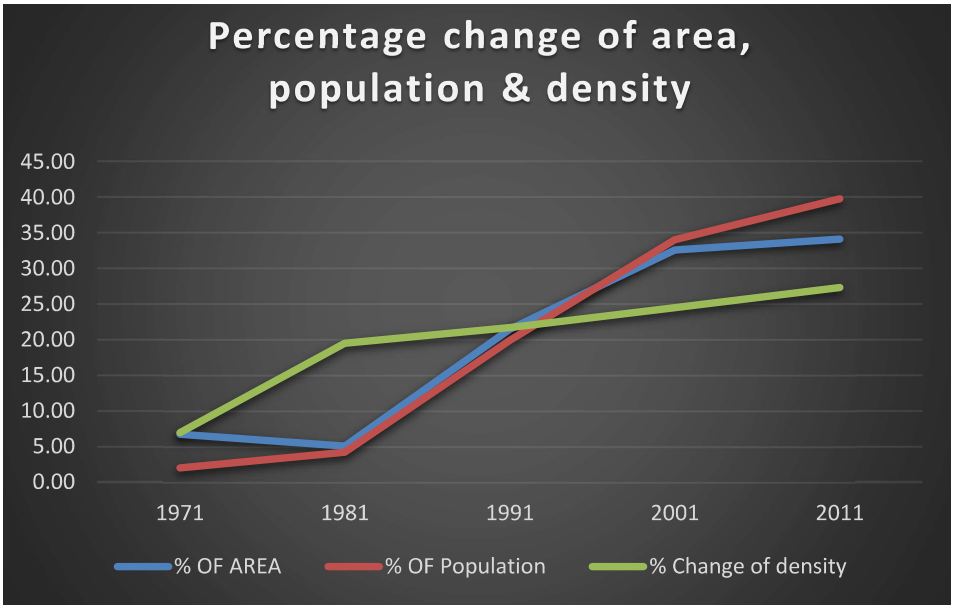

Figure No. 3: Percentage change of area, population, density of Haldia Urban area.

Table 3: Ward wise changes of population density of Haldia Municipality, 2001-2011.

Ward no	Populationdensity/sq. km(2001)	Populationdensity/sq. km(2011)	Densitydifference2011-2001
1	1415.30	1530.29	114.99
2	1669.98	2164.74	494.75
3	1296.72	1589.72	293.00
4	2062.35	2422.58	360.23
5	2232.54	2776.94	544.40
6	778.74	999.39	220.65
7	2652.31	2634.64	-17.67
8	2581.47	1963.51	-617.96
9	2427.39	3588.20	1160.81
10	3041.83	2769.20	-272.63
11	510.47	524.31	13.84
12	1218.56	1371.74	153.18
13	1447.12	1309.23	-137.89
14	2327.96	3465.57	1137.61
15	1765.34	1844.33	78.98
16	1732.96	1527.31	-205.65
17	1943.16	1766.03	-177.13
18	2352.37	2596.53	244.16
19	2503.65	1854.00	-649.64
20	2093.04	2389.94	296.90
21	2342.60	1755.20	-587.40
22	1624.54	1732.61	108.07
23	1325.69	1390.49	64.80
24	1411.27	1994.02	582.76
25	N,A	3343.95	3343.95
26	N.A.	3131.87	3131.87

Source: Census Abstract of Purba Medinipur, 2001-2011

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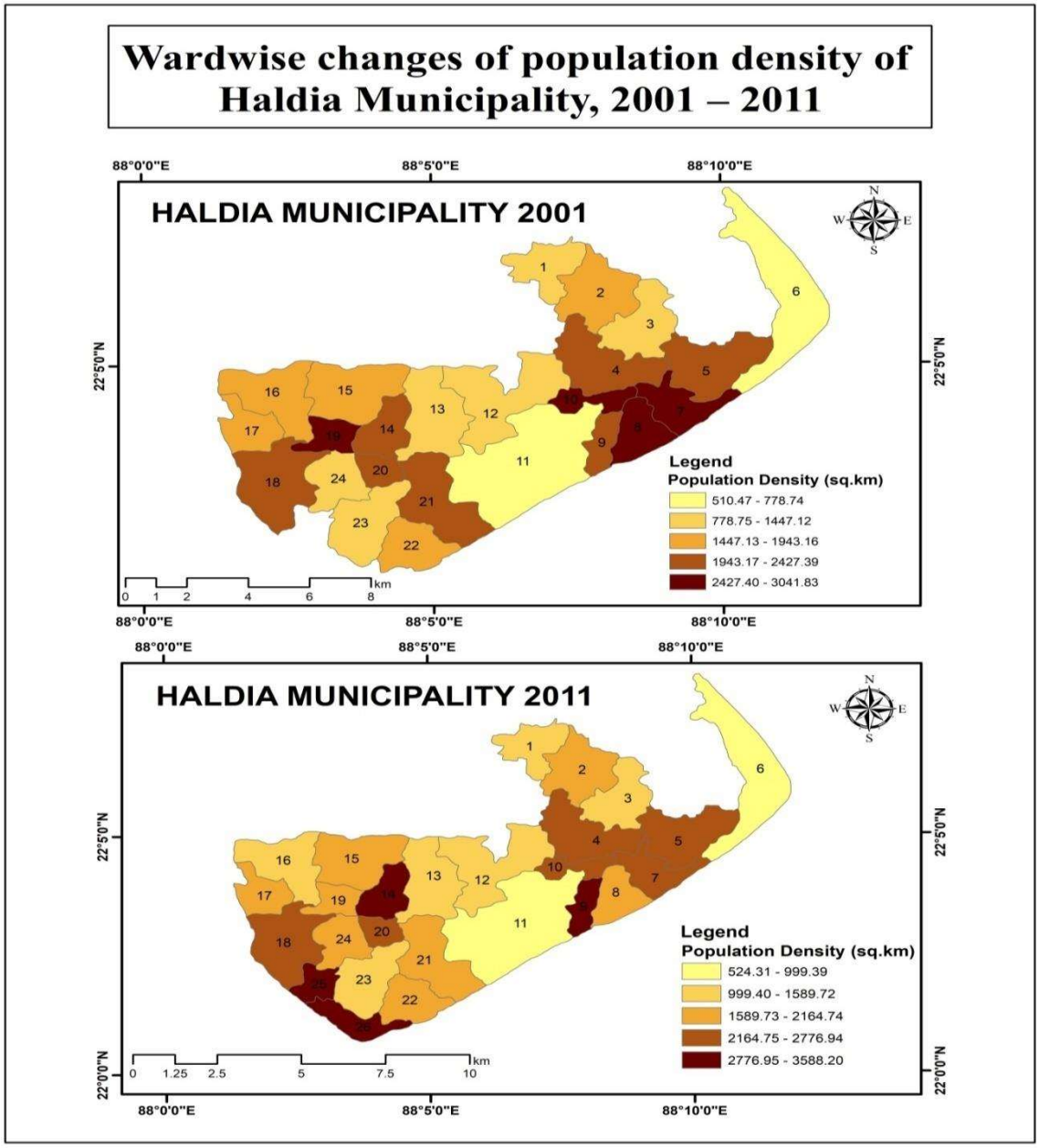

Figure no: 4- Ward wise change of population density of Haldia Municipality

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Haldia musicality is experiencing high population pressure due to changing urban industrial activities and large number of working class people has been migrated from the rural area and city outskirts. The highest population density is found in ward no- 9 and lowest population density is found in ward no-11. In ward number 9.10.14.19.24.25.and 26 population density is more than 3000/sq km where as low population density is found in ward number 6.11.12 due to industrial agglomeration. At a glance population density distribution is clearly noticed in Figure no-4.

Shannon' S Entropy Index:

Shannon's entropy index was employed for assessing the degree of compactness and dispersion of urban physical growth Shannon's entropy , Hn is given by Equation……..

$$H_n = \sum_{i=1}^{n} p_i \log\left(\frac{1}{p_i}\right)$$

Where, Pi is the proportion of a geophysical variable in the I th zone, and n refers to total numbers of zones. The value of the entropy ranges from 0 to log(n). A value closer to zero indicates very compact distribution, whereas a value closer to log (n) indicates the distribution is much dispersed. The halfway mark of log (n) is considered as the threshold value; hence a city with entropy exceeding the threshold value can be called as sprawled city (Bhatta et al. 2010b). In this study ward wise Built-up area is the variable and n is the number of wards.

Municipality Level Entropy of Urban Growth in Haldia

Years	Haldia Municipality		
	Entropy (H_n)	Log(n)	**Half of Logn=0.705**
2000	1.24	1.41	
2016	1.27		

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Table no-5: **Ward Level Entropy In Haldia In 2000 And 2020**

Ward no	Shannon's entropy	
	2000	2020
1	0.079345308	0.126911369
2	0.075410554	0.147087196
3	0.073706349	0.121354654
4	0.116226852	0.152921218
5	0.142283169	0.146900093
6	0.09670751	0.153347282
7	0.15967318	0.152203362
8	0.148738666	0.15036166
9	0.13647863	0.078901332
10	0.159713683	0.123807728
11	0.15581145	0.099629102
12	0.13713374	0.124531869
13	0.118341585	0.124087697
14	0.051357316	0.136380453
15	0.095704051	0.157905142
16	0.067914313	0.124119301
17	0.158265007	0.134520099
18	0.159237214	0.159767763
19	0.120005674	0.151796119
20	0.156925554	0.153644762
21	0.159082752	0.035970257
22	0.150643837	0.152860755
23	0.155782208	0.144566227
24	0.134791661	0.140908651
25	0.153736699	0.138725674
26	0.158834595	0.155211907

In Table no -5 it is found that in ward no 9, 11 and 21 low urban growth is noticed in comparison to 2000 as in these wards receives low economic growth and have recession. In all other wards high space of urban growth is observed.

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Pattern of Urban Growth in Haldia Urban Area (At Haldia Municipal Ward Levels) With The Help of Shannon's Entropy Analysis.

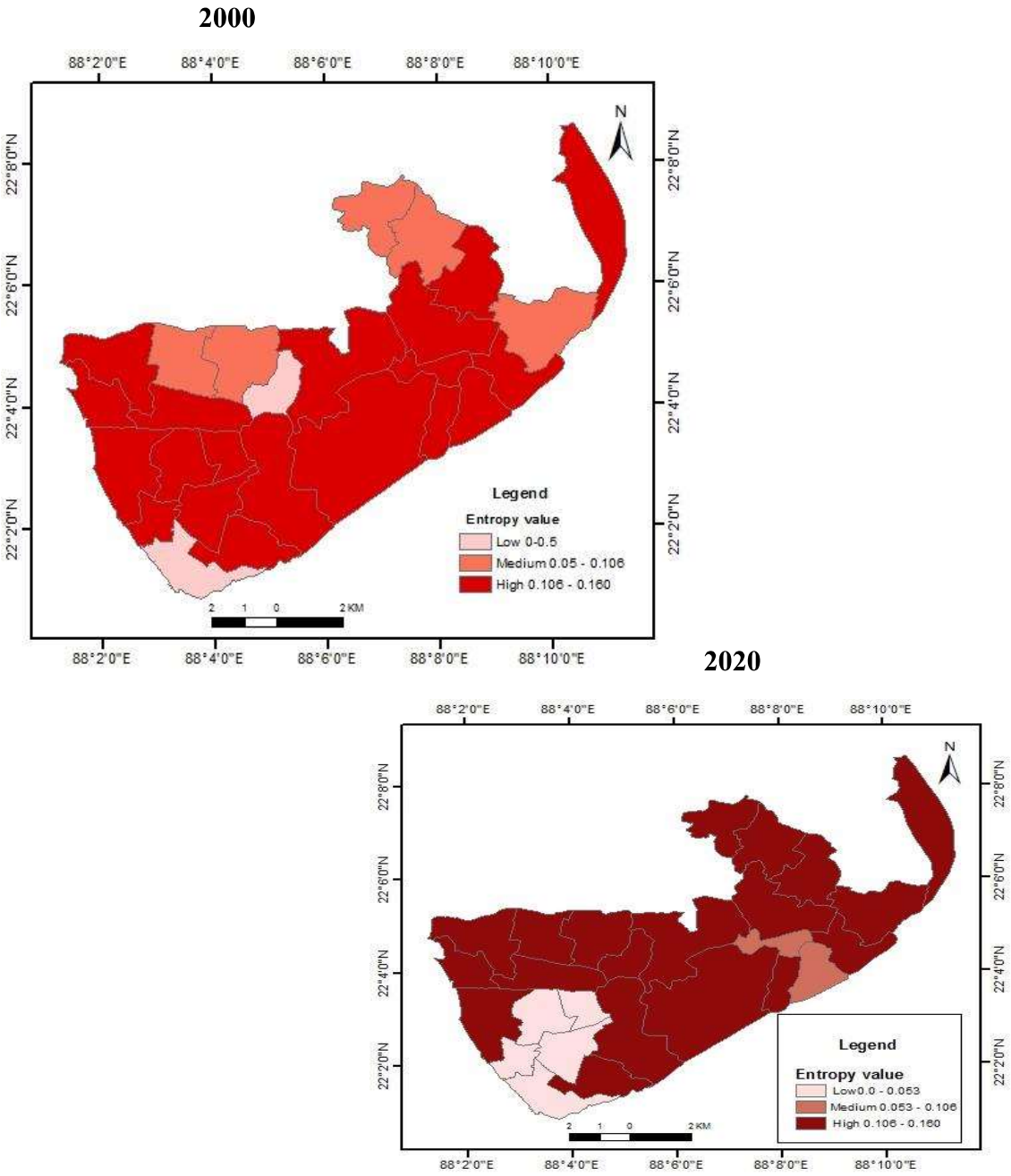

Figure- 5: **Pattern of Urban Growth in Haldia Urban Area**

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6. Industrialization and urban expansion:

Development of Haldia urban industrial complex is traced back to the development of Haldia Dock Complex, founded in 1959. Haldia Urban Industrial complex has developed due to setting up of Haldia Dock Complex as a subsidiary trade port for Kolkata. Haldia industrial complex is basically port based. The industrial town has several factories including South Asian Petrochemicals Limited, Indian Oil Corporation Limited (IOCL), Exide, Shaw Wallace, Tata Chemicals, Petrochemical Complex (Haldia Petrochemical) and Hindustan Lever in addition to various light industries. During 1991 to 2004 about Rs. 10,000/- crore was invested in Haldia industrial complex, which accounted for 36 per cent of total investment in West Bengal.

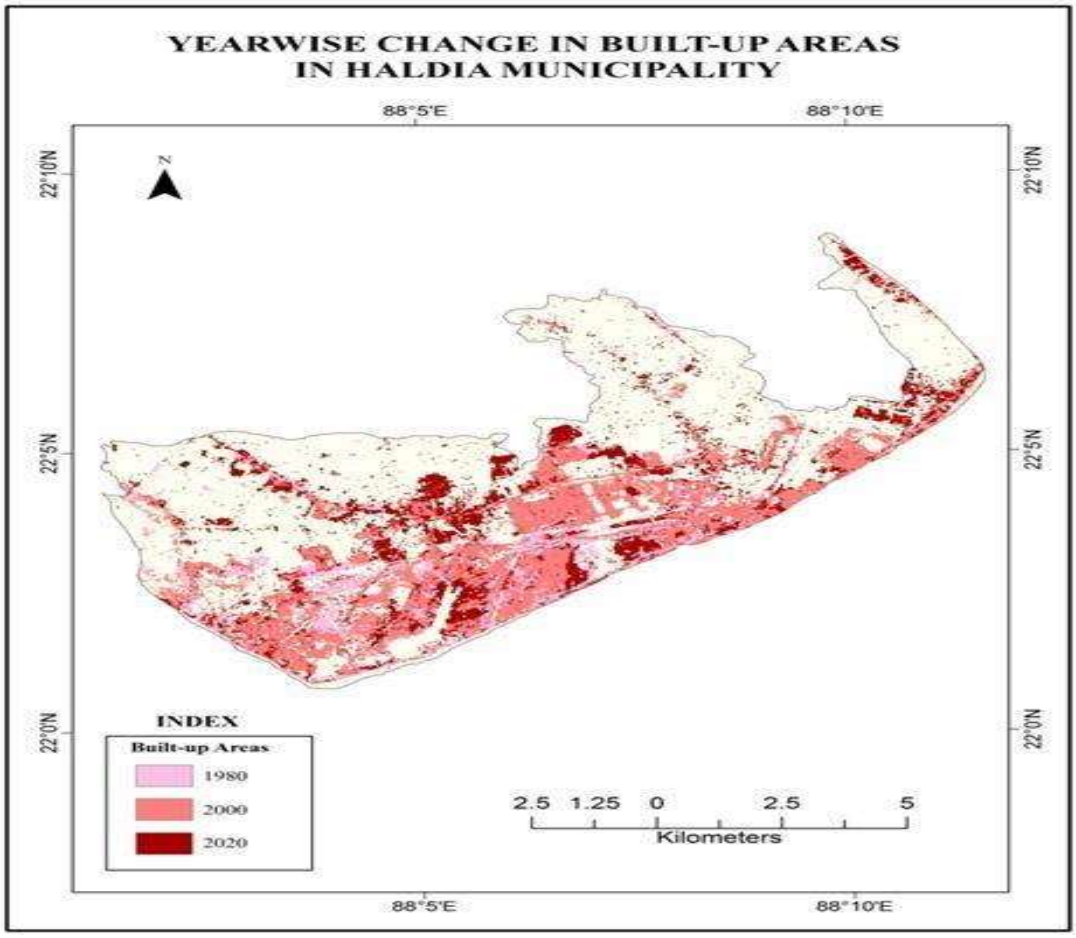

Fig 6: Gradual change in built-up areas of Haldia Municipality, West Bengal for 1980, 2000 and 2020

LULC and NDBI analysis clearly shows that the expansion of Haldia urbanization started along the bank margin of Hooghly river and extended inwards based on industrial growth for a period

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more than thirty years. The Haldia urban area has been expanded towards south-east and western direction along levees of two rivers. The changing scenario of built-up areas in Haldia municipality has been depicted in Figure no-6 which reveals that maximum changes happened in built-up areas during 2020 and new areas have been converted with the establishment of new industrial units, expansion of port areas and activities and expansion of settlement areas.

7. Spatio-temporal characteristics of land use and land cover of Haldia urban area:

Haldia municipality area has undergone through massive changes in terms of land use and land cover over a period of forty years (1980-2020).

The satellite imageries derived these changes which are mentioned in Table no- 5.

	1980		2000		2020	
LULC Classes	Area in sq. km	Percentage	Area in sq. km	Percentage	Area in sq. km	Percentage
Vegetation Cover	47.07	44.39	32.95	31.07	46.57	43.91
Water Bodies	13.08	12.34	11.92	11.24	7.23	6.82
Agricultural Land	40.40	38.09	36.06	34.00	21.68	20.44
Built-up Area	5.50	5.19	25.12	23.68	30.58	28.83

Table no: 5: Land use and land cover classes of Haldia Municipality in different years.

In 1980, the most dominant land cover type was vegetation covering about 47.07km^2 (44.39%) of the total area. The second extensive Land use type was agricultural land which

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covering almost40.40km^2 (38.09%) of the total area. This was followed by water bodies and built-up area which occupied 13.08 km^2 (12.34%), 5.50km^2 (5.19%) respectively. In the year 2000, the area of agricultural land,and vegetation cover was decreased accounting for 36.06 km^2 (38.09%) 32.95km^2 (32.95%) with the notable increase of built-up area 25.12km^2(38.09%) and decreasein the area of water bodies11.92 km^2 (11.24%). However, there is rapid increase of built-up area 30.58 km^2 (28.83%) with the some decrease in agricultural land 21.68km^2(20.44%), water bodies 7.23 km^2(6.82%) and vegetation cover46.57km^2(43.91%) in the year 2020 (Fig7).

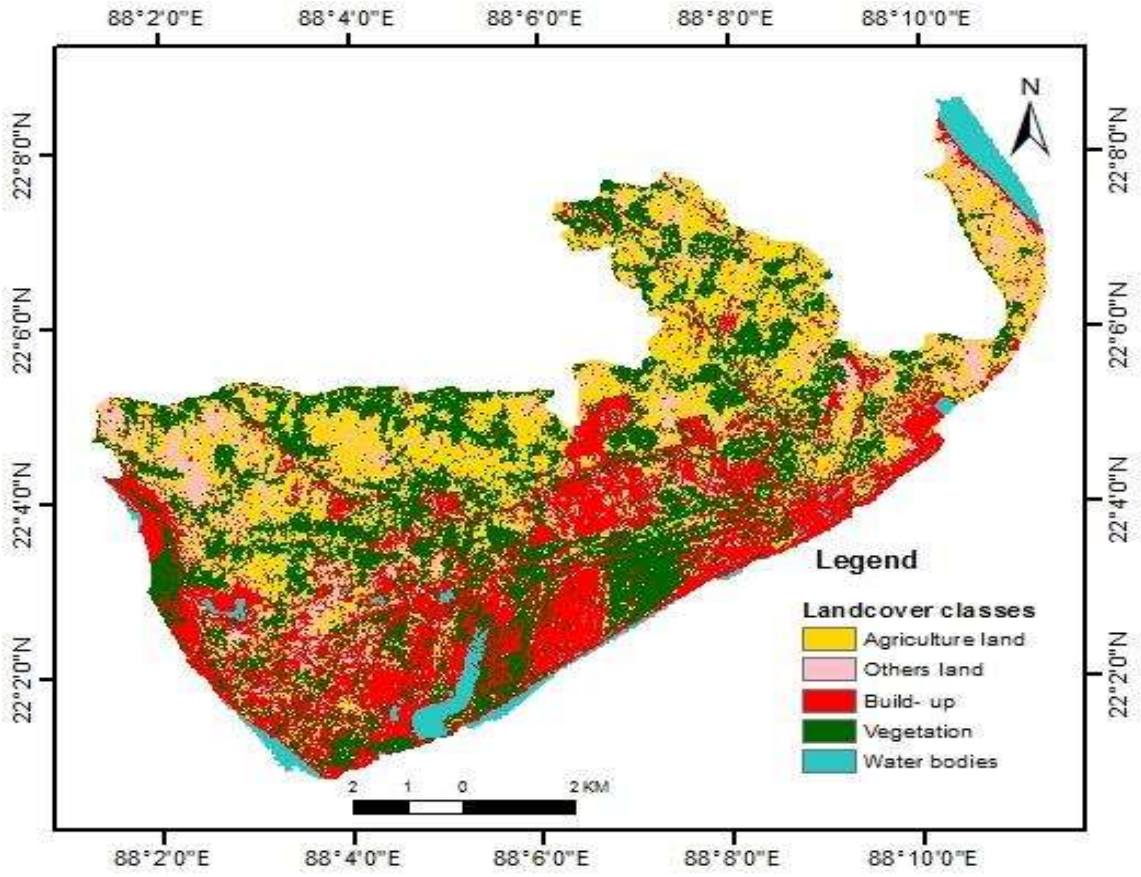

Figure no–7(i): Land use land Cover Map of Haldia Municipality- 2000

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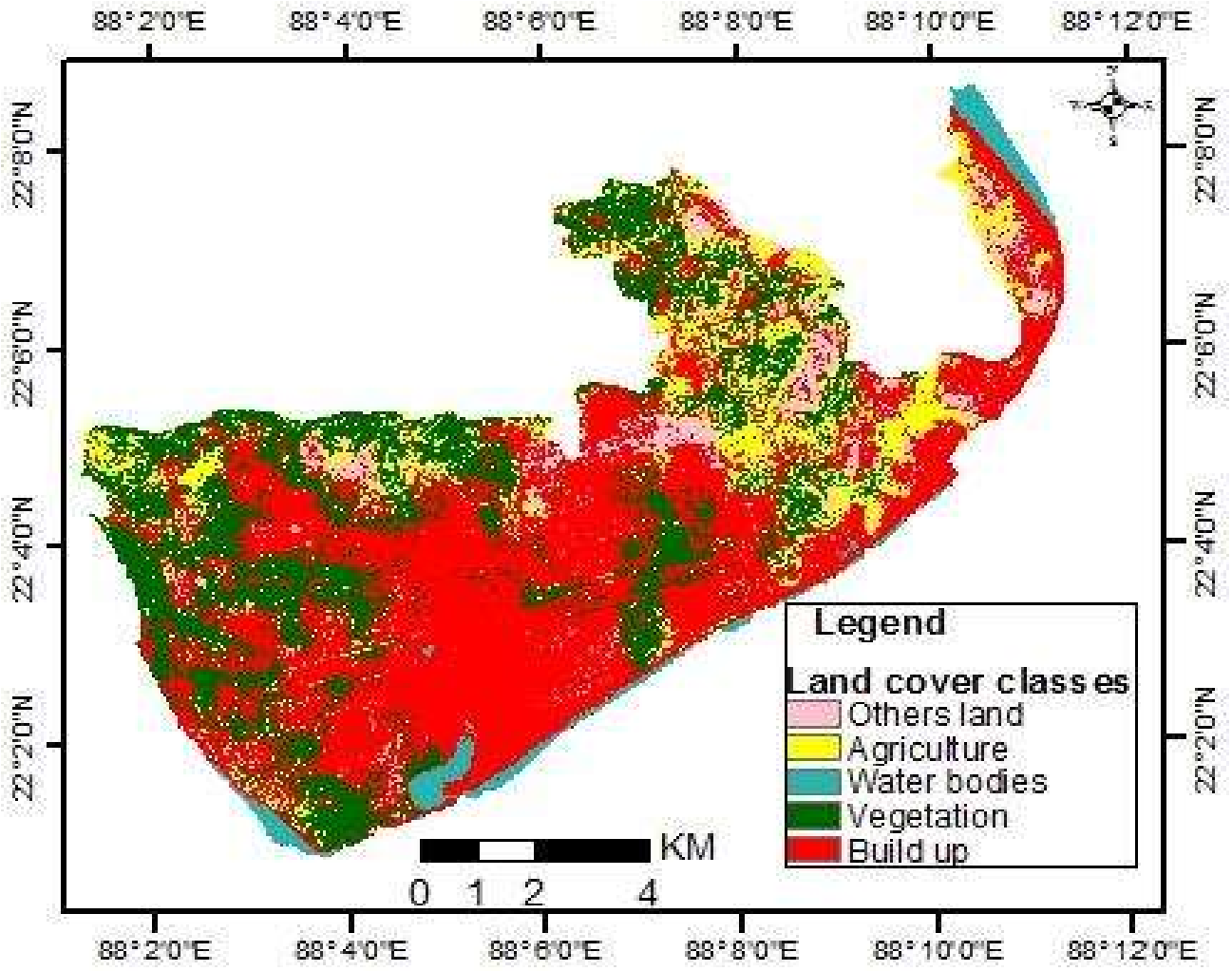

Figure no–7(ii): Land use land Cover Map of Haldia Municipality- 2020

The Post classification LULC statistics comparison method has been attempted to quantify the temporal changes of different classes. During the tenure of 1980 to 2000, the major positive change is noticed only in case of built-up area. area19.62 km^2(18.50%) with decrease in vegetation cover by 13.31%, agricultural land by 4.09%, and Water bodies by 1.09%. Furthermore, in the 2000-2020 timeframe, the vegetation cover has restored by 13.61% with 5.45%increase of the built-up area. On the other hand, the area ofagricultural Land and water bodies has decreased by 13.56% and 4.68% respectively.

However, the data on overall changes of LULC represents the huge expansion of Urban

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settlements in cost of vegetation cover(0.51km^2), Water bodies(5.52km^2), and agricultural land(18.7km^2). The built-up area has increasedalmost five folds i.e., approximately 25km^2 in last 40 years (1980-2020) and mainly concentrated in the south eastern part of the city

8. Major findings:

1. In Haldia urban area built-up growth is very rapid.
2. The phenomenon of urban sprawl is in progress however, the rate of sprawl is low.
3. Outward or peripheral wards are characterized by dispersed growth.
4. Rapid built-up growth have a negative impact on other land covers as it is growth at the cost of other land covers.
5. Compactness in urban growth is increasing at inner side of Haldia town.
6. Shannon entropy proves to be efficient in case like Haldia.

9. Recommended approaches:

i) The residential zone should be planned properly rather than concentration in a particular region.

ii) Need a proper policy to rehabilitate the landless refugees.

iii) The industries need to be nurtured and expanded so that they can offer more job opportunities to the growing population.

iv) Planned sewage system and excavation of sediments would be needful for solving the water logging issues.

v) Different technology should be used by the industries before releasing the wastes and effluents in the environment to control the pollution and they shouldbe aware of the severity of their action.

vi) Different natural and artificial measures for ground water recharge should be taken.

vii) Plantation programme and existing forest protectionschemes should be developed to restore ecological imbalance.

viii) Last but not the least, awareness generating initiatives to sensitize the locals about the problems of the industry-urban expansion and feel importance of preserving environmental resources.

ix) To implement a comprehensive plan for the development in light of preserving the quality of life and environment so that an acceptable sustainable development is kept in space.

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10. Conclusion:

In the context of Haldia Municipality land use planning and policy making decisions are entrusted to local bodies. Of course Haldia Development Authority has adopt a future or long range plan called „master plan or vision plan prepared by the IIT, Kharagpur to determinethe type of development in the Haldia notified area including Haldia municipality. Haldia municipality is situated in a sensitive estuarine environment. The continuous modifications of landscape due to the unplanned urban growth are increasing the risk and vulnerability of the area day by day. Although there are some existing management plans, but they are not sufficient to tackle the resultant environmental complexities.

A detail land use plans and decision making process involving participation of local people, professionals, legal experts, planners and many should enforce. Specific management plan with participatory approach should be introduced for the awareness of the residents and sustainable development of the area.

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