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APPRAISAL OF MULTIFACETED URBAN DEVELOPMENT OF NORTH 24 PARGANAS, WEST BENGAL- A CASE STUDY

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ABSTRACT

North 24 Parganas District, lying in the deltaic Bengal, comprises of several rivers, tidal channels, wetlands and premature deltaic lowland. Geographically, it is a bordering district of West Bengal, which is highly affected by migration at the time of independence of India. Rapid population growth due to high birthrate and migration as well occupy a social space of the region. Galloping urbanization takes place in haphazard manner. The work aims to measure the urban development and its impact on the status of the blocks of the district. For this study IRS LISS III images were used. For ground truthing, some strategic location of study area was taken from satellite images and Global Positioning System (GPS) survey. Census data of 2001 and statistical handbooks of 2008 were used for population density zoning. The correlations between different variables like population density, road density, educational facility, health facility, banking and transport etc. were calculated.

KEYWORDS: Urban development, Imperviousness, Multiple correlations, Dendrogram.

1. Introduction

Over the last few decades, most of the developing countries have experienced an unprecedented increase in urbanization (Erick F. N. Akotsi, Jacob K. Ndirangu, 2006). Urbanization has become a principal manifestation and at the same time an engine of change (Ravindra Kumar Verma1, Sangeeta Kumari,and R. K. Tiwary 2008). Total population of North 24 Parganas of West Bengal was 5529497 in 1981 to 10,082,852 in 2011. Total population increased 1.8 times within this period. Urban population of this district was 2.89 million (51% of total) in 1981, which increased to 5.8 million (57.6% of total) in 2011. The urban development occurs mainly along the Sealdha-Bongaon railway line and along the National Highways- 34, 35. Barasat gets special hike as a district headquarter of North 24 Parganas since mid-eighties of the last century. From Kolkata to Barasat the urbanization takes place along the major roads and railway line. After that it continues towards Bongaon but it remains less attractive as a settlement pace towards Basirhat due to the presence of the wetland of the deltaic region. Here the natural landscapes are the deterministic factor of the land use pattern. On the other hand, the flows of the tidal channels- Sunti, Noai are choked by the construction of settlement, agricultural practices and the brickfields along Nonagaon. It causes the stagnation of the shallow water bodies resulting in loss of agricultural land. The present study reveals the dichotomy of the development.

2. Study area:

The geographical location of North 24 Parganas is between 22º05′54″N to 23º16′39″N of latitude and 88º20′03″E to 89º06′34″E of longitude. Total area of the North 24 Parganas is about 4122.7628 km². The district lies within the Ganges-Brahmaputra delta. The river Ganges flows along the western border of the district. There are many other rivers, which include the Ichhamati, Jamuna, Bidyadhari and Padma etc. The climate is tropical, like the rest of the Gangetic West Bengal. The hallmark is the Monsoon, which lasts from early June to mid-September, and the temperature rises up to 41ºC in summer and 10ºC in winter. The district comprises 22 blocks with 27 municipalities and 200 Gram Panchayats. This area is connected with Eastern railways and National highways NH34 and NH35, Grand Trank (GT) road to the other places of West Bengal. Calcutta is only 15 KM from Barasat, the head quarter of this district.

3. Materials and Methods:

3.1. The map of North 24 Parganas District along with block boundaries and urban centres; Source: Census of India (2001), Government of India.

3.2. IRS LISS III image of 2008(February); Source: National Remote Sensing Agency (NRSA).

3.3. Census data of 2001, Census of India

3.4. District Statistical Handbook of the year 2008, North 24-Parganas, Bureau of Applied Economics and Statistics, Government of West Bengal.

3.5. GPS data were collected from some strategic location and some specific land use of North 24 Parganas.; Source: field survey by the investigators

4. NDVI of North 24 Parganas image:

Landsat MSS, TM and IRS LISS III images of North 24 Parganas are enhanced with Normalized Difference Vegetation Index (NDVI). NDVI is a ratio used to determine the density of vegetation in an area based on visible and near-infra red (NIR) sunlight reflected by plants. NDVI is defined by NDVI= (NIR-R)/ (NIR+R). The chlorophyll in plants leaves strongly absorbs visible light (From 0.4 0.4 μm to 0.7 μm) for use of photosynthesis. On other hand chlorophyll strongly reflects NIR light (from 0.7 μm to 1.1 μm).) This reflection is proportional to the amount of green leaves. Vegetated areas will give positive values due to their high reflectance in NIR and low reflectance of the visible spectrum. On the other hand, bare areas or areas with very sparse vegetation cover have higher reflectance in the visible spectrum than NIR, leading to negative and near zero NDVI values *(Larry Ryan 1997).*

Table 1: Result from different NDVI images of North 24 Parganas.

Value	LISS III 2008
Maximum	+0.35238
Minimum	-0.83099

5. Methods for calculating the normalized weighted scores of different variables:

The population density and variables of urban characteristics like road density, educational facilities, banking facilities, health care facilities, transport facilities and impervious areas are considered as urban growth indicators. Imperviousness of different blocks are determined from unsupervised classification using NDVI values of 2008. Data on different variables are weighted, e.g. in case of Educational institution (Ei)- Primary School has given weightage of 5, Middle School of 10, High School of 15, Higher Secondary School of 20, Professional Institution of 20, College/ University of 25 and Special/Non formal Institution of 1 were given. Different weighted score of the variables of the blocks are normalized for getting comparative status of different variables: NWSV= WS/ MWV. Where NWSV is the Normalized Weighted Score of Blocks for a particular variable, WS is the Weighted Score of the variable for a particular block and MWV is the Maximum weighted value of the variable for the 19 blocks. The normalized weighted score of the variables are illustrated in the Table 2.

6. Multiple regressions of the variables:

Simple linear correlation and regression analysis deals with the case of the relationship between two variables of which, one is dependent variable Y and the other is an independent explanatory variable X. However, in the analysis of relationship between two real variables over a set of observations, it is rare to discover an association so obvious and so comprehensive that the coefficient of correlation represents a perfect relationship, i.e., = ±1 and all the variations in the independent variable X account for the dependent variable Y (Das. S. and Betal. H. R. 2005). Hence, multiple regression is the extension of simple linear regression to take into account the effect of more than one independent X variables on the dependent variable Y. The multiple regression analysis by least square method is done by considering six independent variables in the analysis. The general equation is $y_c = a+b_1X_1+b_2X_2+ b_3X_3+ b_4X_4+ b_5X_5+ b_6X_6$. The mathematical calculation of multiple regression analysis by least square method is done by MINITAB 14 software.

7. Results and discussion:

Unsupervised classification of NDVI images for pervious and impervious area of North 24 Parganas from 2008.

Unsupervised classification (ISODATA) is done on NDVI images separately. Depending on the differences in vegetative coverage, pervious and impervious areas are calculated in percentage. For the year 2008 NDVI value varies from -0.008 to +0.025 The impervious area in 2008 impervious area is 16.4 percent in 2008 (Table 3). In this way we have calculated pervious area and impervious area in percentage of each blocks of North 24 Parganas district for the year 2008 (figure 1).

Table 3: Classification of images of North 24 Parganas based on NDVI

Category	IRS LISS III 2008		
	Minimum	Maximum	Area in %
Pervious Area	-0.83009 to -0.008	+0.025 to +0.35238	83.6
Impervious area	-0.008	+0.025	16.4

Results of normalized weighted scores of the variables:

Here the population density (Y) is the dependent variable and the six independent variables are road density (X_1), health facility (X_2), education facility (X_3) transport facility (X_4), banking facility (X_5), and imperviousness (X_6) of 22 blocks (n) in North 24 Parganas district for 2008. After normalization the weighted score of the variables are shown in the Table 2.

Barrackpore II block holds the first rank of normalized weighted score in case of Population density and road density, followed by Bidhannagar and Barrackpore I respectively. Barrackpore II is also in the first rank for health facility and education facility followed by Barasat I & II, Barrackpore I and Habra I&II respectively.

Table 2: Normalized weighted score of different variables of the blocks of North 24 Parganas district, 2008

Name of CD Block	Normalized weighted Score of Population density	Normalized weighted Score of Road density	Normalized weighted Score of Health facility	Normalized weighted Score of Education facilities	Normalized weighted Score of Transport facilities	Normalized weighted Sore of Banking facilities	Normalized weighted Score of Imperviousness
	Y	X_1	X_2	X_3	X_4	X_5	X_6
Amdanga	0.087281	0.057105	0.299517	0.091513	0.123077	0.370786	0.1379970
Baduria	0.107014	0.191481	0.439613	0.248469	0.338461	0.269663	0.2321409
Bagdah	0.069030	0.094510	0.396135	0.135529	0.169230	0.213483	0.1065105
Bangaon	0.090523	0.149069	0.666666	0.251214	0.507692	0.449438	0.2482040
Barasat I & II	0.214269	0.244383	0.801932	0.346949	1	0.662921	0.2047002
Barrackpore I	0.539238	0.50711	0.579710	0.512033	0.769230	1	0.6635048
Barrackpore II	1	1	1	1	0.692307	0.887640	0.4494485
Basirhat	0.127660	0.143516	0.545890	0.27633	0.446153	0.325842	0.2292225
Bidhannagar	0.359415	0.727307	0.028985	0.06839	0.784615	0.853932	0.8474443
Deganga	0.099897	0.117150	0.425120	0.16476	0.246153	0.247191	0.2285918
Gaighata	0.090582	0.174399	0.516908	0.17964	0.307692	0.258427	0.0993609
Habra I & II	0.132858	0.183148	0.714976	0.39476	0.292307	0.426966	0.2650484
Haroa	0.087620	0.136352	0.318841	0.09299	0.230769	0.168539	0.1192321
Hasnabad	0.093415	0.097338	0.444444	0.14640	0.138461	0.101123	0.2013539
Hingalganj	0.048019	0.027144	0.454106	0.13458	0.076923	0.044943	0.0538630
Minakhan	0.078002	0.020233	0.323671	0.13933	0.153846	0.044943	0.0943195
Rajarhat	0.283560	0.308996	0.502415	0.15104	0.507692	0.303370	1
Sandeshkhali I & II	0.053474	0.075345	0.753623	0.20815	0.184615	0.247191	0.0926091
Swarup Nagar	0.077230	0.060688	0.371981	0.14608	0.230769	0.168539	0.0772259

In case of transport facilities, Barasat I & II take the highest position followed by Bidhannagar. Banking facilities are higher in Barrackpore I block followed by Barrackpore II and Bidhannagar. Due to New Township project in Rajarhat block in past few years imperviousness gets highest position followed by Bidhannagar block. Hingalganj block is in the lowest ranking for population density, transport and banking facilities. Bidhannagar is another city ranked lower in case of health and education facilities, because private health care institutions, private banks and private educational institutions are not taken into consideration.

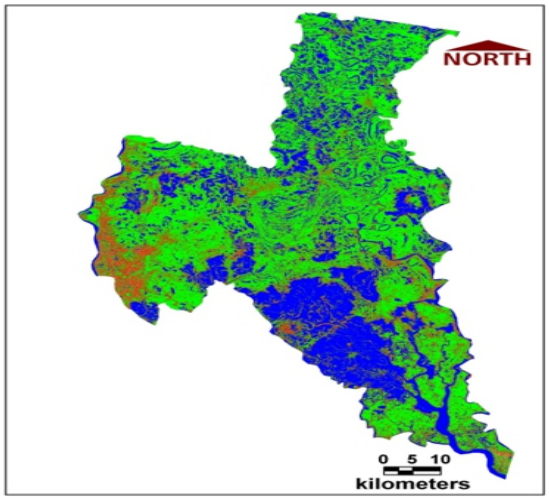

Figure 1: ISODATA classification of NDVI image

Multiple Correlations of Different Variables:

Thus the estimated regression equation according to least square method for the present study may be expressed as $Y_c = -0.0199 + 0.154\,X_1 - 0.172\,X_2 + 0.986\,X_3 - 0.113\,X_4 + 0.028\,X_5 + 0.194\,X_6$. The above expression can be interpreted as the value of a = -0.0199, the estimated value of Y increases by 0.154, 0.986, 0.028 and 0.194 for each unit change of X_1, X_3, X_5 and X_6 respectively and decrease by 0.172 and 0.113 for each additional unit in X_2 and X_4 respectively. Multiple correlation indicates the strength of relationship between dependent and set of independent variable.

The multiple correlation ($R_{y,123456}$) generally be expressed as $R^2_{y,123456} = 1 - \frac{\sum(Y-Yc)^2}{\sum(Y-\bar{y})^2}$.

The R^2 obtained from the equation $R^2_{y,123456} = 0.923479$. Thus the positive square root of the value yields the multiple correlation coefficient to be 0.960978. The multiple correlation indicates that there is strong correlation between population density with the number of different urban indicators. On the other hand partial correlation for the independent variables X_1, X_2, X_3, X_4, X_5 and X_6 have been found to be 87.8%, 47%, 90.6%, 42.8%, 62.2% and 31% respectively.

Pearson Multiple correlation coefficient values among variables are illustrated in the Table 5. The Pearson Correlation coefficient value of the variables ranges from 0.385 to 0.937. There is no negative value that means all relations are positive linear. Population density and Educational facility has the highest correlation coefficient value with 0.952 followed by population density and road density has 0.937. The lowest correlation coefficient value is 0.385 between Educational facility and imperviousness. P value between imperviousness and Health, Education are below significant level (0.01) It means the correlation between population density and road density, educational facility, banking facility are highly significant.

Dendrogram with Single Linkage and Correlation Coefficient Distance:

Dendrograms are a convenient way of depicting pair-wise similarity and dissimilarity between objects, commonly associated with the topic of cluster analysis. Essentially, the level at which branches merge (relative to the "root" of the tree) is related to their similarity. The results of cluster analysis are shown by Dendrogram , which lists all of the samples and indicates at what level of similarity any two clusters were joined. The Y-axis is some measure of the similarity or distance at which clusters join and different programs use different measures on this X-axis (Steven M. Holland 2006). In the dendrogram it is clear that population, road, education transport and banking facility are more similar and join to form the first cluster with 92.13 percent similarity, followed by health facility and imperviousness with 88.86 and 83.22 percent similarity respectively (Figure 2).

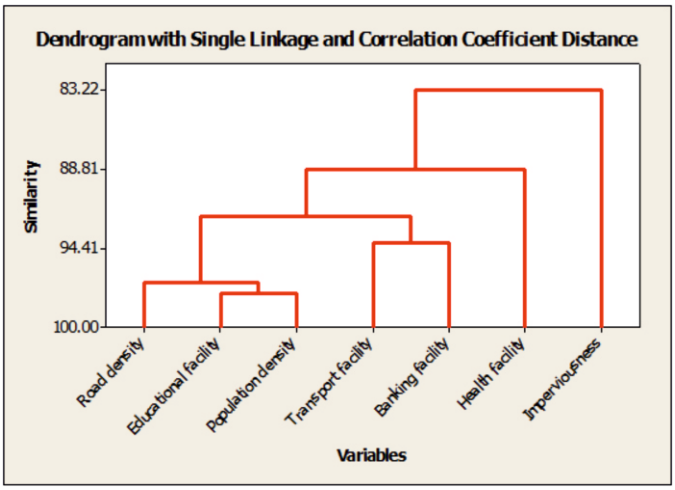

Figure 2: Dendrogram

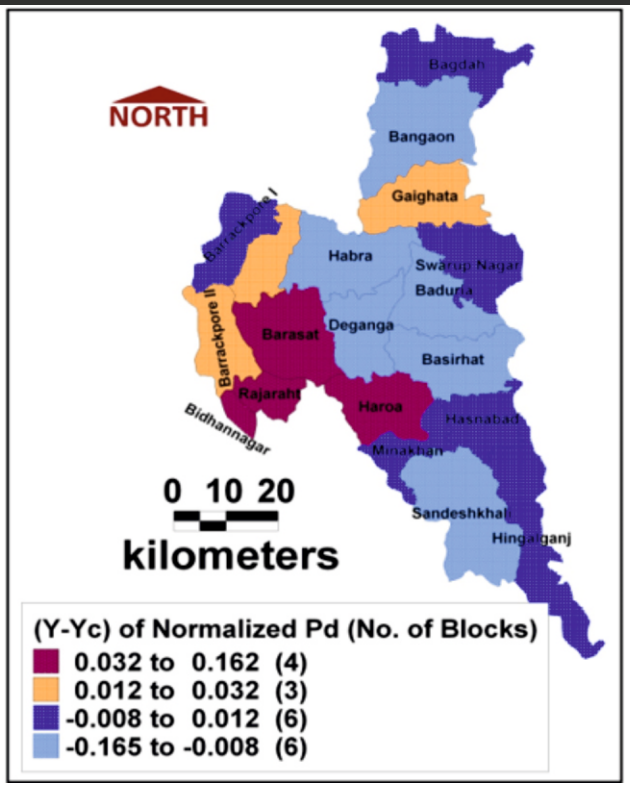

Figure 3: Residual Map of population

Table 4: Parametric calculations for multiple correlation

Block	Y	b_1X_1	b_2X_2	b_3X_3	b_4X_4	b_5X_5	b_6X_6	Yc	Y-Yc	$(Y-Y_c)^2$	$Y-\bar{Y}$	$(Y-\bar{Y})^2$
Amdanga	0.087	0.0134	-0.0515	0.0902	-0.0139	0.010	0.026	0.0555	0.032	0.0010	-0.104	0.0108
Baduria	0.107	0.0165	-0.0756	0.245	-0.0382	0.007	0.045	0.1803	-0.073	0.0053	-0.084	0.0071
Bagdah	0.069	0.0106	-0.0681	0.1336	-0.0191	0.006	0.021	0.0637	0.005	0.0000	-0.122	0.015
Bangaon	0.090	0.0139	-0.1146	0.2477	-0.0574	0.012	0.048	0.1304	-0.04	0.0016	-0.101	0.010
Barasat I & II	0.214	0.033	-0.1379	0.3421	-0.113	0.018	0.039	0.1625	0.051	0.0026	0.023	0.0005
Barrackpore I	0.539	0.0830	-0.0997	0.5049	-0.0869	0.028	0.128	0.5381	0.001	1.3099	0.347	0.121
Barrackpore II	1	0.154	-0.172	0.986	-0.0782	0.025	0.087	0.9819	0.018	0.0003	0.808	0.653
Basirhat	0.127	0.0196	-0.0939	0.2725	-0.0504	0.009	0.044	0.1815	-0.054	0.0029	-0.064	0.004
Bidhannagar	0.359	0.0553	-0.0049	0.0674	-0.0887	0.023	0.164	0.1975	0.162	0.0262	0.168	0.028
Deganga	0.099	0.0154	-0.0731	0.1625	-0.0278	0.007	0.044	0.1083	-0.008	0.0001	-0.091	0.008
Gaighata	0.090	0.0139	-0.0889	0.1771	-0.0348	0.007	0.019	0.0740	0.016	0.0003	-0.101	0.01
Habra I & II	0.133	0.0204	-0.1229	0.3892	-0.033	0.012	0.051	0.2971	-0.164	0.027	-0.058	0.0034
Haroa	0.087	0.0135	-0.0548	0.0917	-0.0261	0.004	0.023	0.0322	0.055	0.0030	-0.104	0.0108
Hasnabad	0.093	0.0144	-0.0764	0.1444	-0.0156	0.003	0.039	0.0886	0.005	0.0001	-0.098	0.009
Hingalganj	0.048	0.0049	-0.0781	0.1327	-0.0087	0.001	0.010	0.0451	0.003	8.5281	-0.143	0.021
Minakhan	0.078	0.0120	-0.0557	0.1374	-0.0174	0.001	0.018	0.0759	0.002	4.0447	-0.113	0.01289
Rajarhat	0.2836	0.04367	-0.08642	0.1489	-0.0574	0.0085	0.194	0.23141	0.0522	0.00272	0.092	0.008
Sandeshkhali I & II	0.0535	0.00824	-0.12962	0.2052	-0.0209	0.0069	0.018	0.06797	-0.014	0.0002	-0.138	0.019
Swarup Nagar	0.0772	0.01189	-0.06398	0.144	-0.0261	0.0047	0.015	0.06568	0.0116	0.00013	-0.114	0.013

Table 5: Multiple Correlations: Population density, Road density, Health facility, Educational facility, Transport facility, Imperviousness. Cell content: Pearson correlation (P-Value)

	Population density	Road density	Health facility	Educational facility	Transport facility	Imperviousness
Road density	0.937 (0.00)	-	-	-	-	-
Health facility	0.686 (0.001)	0.734 (0.00)	-	-	-	-
Educational facility	0.952 (0.00)	0.890 (0.00)	0.777 (0.0)	-	-	-
Transport facility	0.654 (0.002)	0.731 (0.00)	0.777 (0.0)	0.692 (0.001)	-	-
Imperviousness	0.557 (0.013)	0.664 (0.002)	0.441 (0.059)	0.385 (0.103)	0.592 (0.008)	-
Banking facility	0.789 (0.000)	0.843 (0.00)	0.702 (0.001)	0.779 (0.00)	0.881 (0.00)	0.614 (0.005)

The regression equation is
Population = - 0.0199 + 0.154 Road density - 0.172 Health facility + 0.986 Educational facility - 0.113 Transport facility + 0.028 Banking facility + 0.194 imperviousness

Conclusion:

The result of multiple correlation shows that most of the blocks have negative expected value in health facility and transport facility. The residual values of the blocks like Baduria, Bongaon, Basirhat, Habra I & II and Sandeshkhali I & II are negative. Possibly on account of proximity to international border with Bangladesh, the actual population densities of those blocks are lower than the expected population density. On the other hand Bidhannagar, Rajarhat and Barasat I & II blocks are at higher residual value of population density. In these regions Population density is higher due to planned development and nearness to Kolkata (Figure 3).

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REFERENCE:

1. Akotsi F. N. Erick, Gachanja Michael, K. Ndirangu Jacob (2006), Changes in forest in Kenya's five "Water Tower" 2003- 2005. (Kenya Forests working group, East Africa Wild Life Society, 7-10
2. Congalton, R.G., Green, K., In: Lyon, J.G., Raton, B. (Eds.) (1999), Assessing the Accuracy of Remotely Sensed Data: Principles and Practices. Mapping Science Series, Durham.
3. Ravindra Kumar Verma1, Sangeeta Kumari and R. K. Tiwary (2008), Application Of Remote Sensing And Gistechnique For Efficient Urban Planning In India, National Institute of Industrial Engineering, Mumbai, India.
4. Ryan Larry (1997): Creating a Normalized Difference Vegetation Index (NDVI) Image using Multi Spec. Proc.The GLOBE Program. University of New Hampshire. Durham, 1-2.
5. Sharmistha. Das (Roy) and H. R. Betal (2005), The role of educational institution on literacy: multiple regression modeling in Hugli, West Bengal, Geographical Review of India, 67(1), 23-36.