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Suitable Site Selection For Sustainable Urban Development Planning With The Help Of Remote Sensing And GIS

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Abstract: ***The work includes the findings and results of suitable site selection for the sustainable urban development, carried out in the Dhanbad Block in Jharkhand. The precise aim of this present study is to find out suitable site for urban development and planning in Dhanbad block. Such growth has been facilitated by rapid development in transport and communication and new economic opportunities mostly found in the surrounding regions of an urban centre. This kind of growth later on takes different shapes in different directions. Using Landsat 5 satellite image, DEM image, Toposheet & other data of Dhanbad block monitor the land use/land cover pattern for sustainable urban development planning and identify suitable urban development site with various utility services of Dhanbad block. It facilitated to understand the complexities of a dynamic phenomenon such as suitability site for urban development planning, land use/land cover benefits, urban development planning pattern. Includes the digitization of various layers, preparation of maps, field work and other RS / GIS technique i.e., Georeferencing, Digitization, Attribution, Data attachment, proximity of features, Overlay analysis, unsupervised classification, were analyzed. A major component of this, survey and analysis. Review of modern techniques and methodology adopted for the study is also discussed in detail. This comprises the profile of the study area that gives a detailed account of location of study area, extent and aerial coverage of the study area at the Dhanbad District, Jharkhand, India. Thus including weighted value to the features as per the requirement for the suitable site selection for the sustainable urban development planning. In this study Ganshadih, Jatudih, Jharma, Sabaldih, Kustuk, Brlihahi, Kusunda, Phutha, Dhabanil, Basuria, Ekra, Goreria, and also other some part of Nawadih, Dhansar, Bera, Narayanpur Dhariojoba, Godhar, Chirudih and Samshikhary are the suitable site for future urban development.***

Keyword: Georeferencing, Digitization, RS, GIS, Unsupervised, Proximity, Weighted, Overlay Analysis.

I. INTRODUCTION

Urban development is the social, cultural, economic and physical development of cities, as well as the underlying causes of these processes. Dhanbad (Jharkhand, India) are growing at a very fast rate, acquired a complex urban structure over the years. The central part or the core has gone through unusual changes in terms of social and physical transformations. Planning Theory is the body of scientific concepts, definitions, behavioural relationships, and assumptions that define the body of knowledge of urban planning. (Almedia B. 2005). Technical Aspects of Urban Planning involve the applying scientific, technical processes, considerations and features that are involved in planning for land use, design, natural, transportation, and infrastructure. Urban planning includes techniques such as: predicting

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population growth, zoning, geographic mapping and analysis, analysing park space, drinking water availability, identifying transportation patterns, recognizing food supply demands, allocating healthcare and social services, and analysing the impact of land use (Taylor, Nigel, 2007).

II. STUDY AREA

Dhanbad district is one of the twenty-four districts of Jharkhand state, India, Dhanbad is the administrative headquarters of this district. As of 2011 it is the second most populous district of Jharkhand. According to the 2011 census Dhanbad district has a population of 2,682,662, roughly equal to the nation of Kuwait or the US state of Nevada. This gives it a ranking of 148th in India (out of a total of 640).The district has a population density of 1,284 inhabitants per square kilometre (3,330/sq. mi). Its population growth rate over the decade 2001–2011 was 11.91%. Dhanbad has a sex ratio of 908 females for every 1000 males, and a literacy rate of 75.71% (Wikipedia). The latitude & longitude of the Study area is $86^0$18'46.73"E to $86^0$29'23.40"E longitude & $23^0$51'8.31"N to $23^0$42'3.82"N latitude the study area map in (Fig-1).

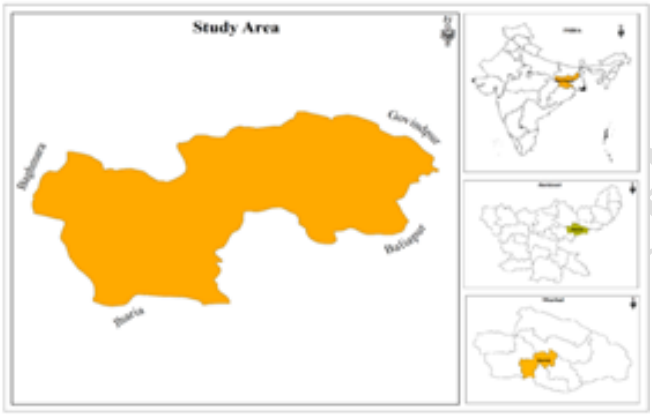

Figure 1: Location Map of the Study Area

III. RIVER

River is a natural flowing water course, usually fresh water, flowing towards an ocean, sea, lake or another river Damodar River is the main river flowing through the district. Katri, Jamunia, Gobai, Khudia and Jiri are the other rivers flowing through the district (Fig-2). The river channel typically contains a single stream of water, but some rivers flow as several interconnecting streams of water, producing a braided river. Extensive braided rivers are now found in only a few regions worldwide. (Wikipedia).

Figure 2: Drainage Map of Dhanbad Block

IV. POPULATION PRESSURE

Population Pressure is the sum of the factors within a population that reduce the ability of an environment to support the population and that therefore tend to result in migration and expansion of range or in extinction or decline of the population. The population density of study area is 1316/sq km. The (Figure-3) represents population pressure in the study area.

Figure 3: The Map of Population Pressure

V. HILL SHADE

A hill shade is a gray scale 3D representation of the surface, with the sun's relative position taken into account for shading the image. This function uses the altitude and azimuth properties to specify the sun's position (ESRI). For gridded terrain data, the cosine of the angle between a surface normal vector and a vector representing the illumination direction defines the gray value of each surface unit (Horn, 1982). In this study area Dhanbad block the highest and lowest value are showing 0 to 181m above mean sea level. Hence below (Fig-4) map is showing the hill shade of study area.

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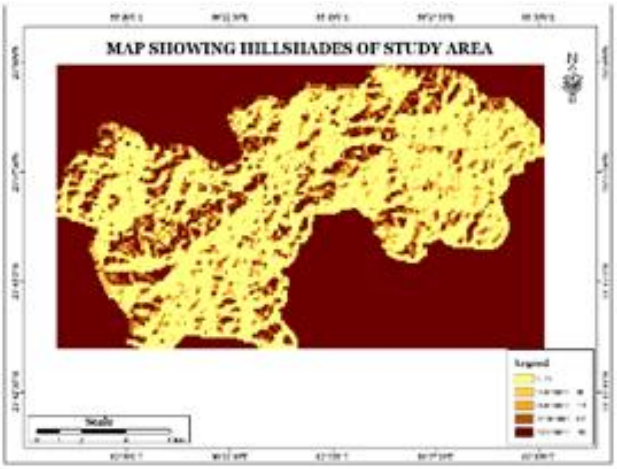

Figure 4: The Hill shade Map of the Study Area

VI. SLOPE

Slope identifies maximum rate of change in value from each cell to its neighbours or a measure of change in surface value over distance, expressed in degrees or as a percentage. The lower the slope value, the flatter the terrain; the higher the slope value or degree of slope (Fig-5) showing the slope map of the study area. The study area Dhanbad block slope map represents the surface slope in the study area, the highest slope is 64.31 degree.

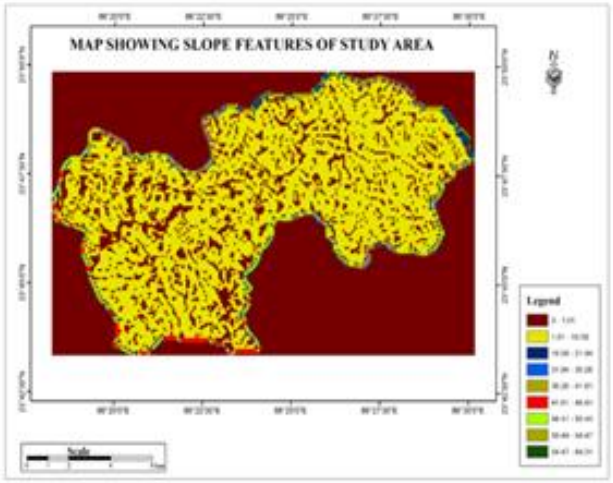

Figure 5: The Slope Map of the Study Area

VII. GROUND WATER LABEL

Water plays a vital role in every biological society in the globe. The socio economic development of a region predominantly depends on the availability of good quality water. (Amit Ghosh, 2015). In the study area Dhanbad block four zone are divide into ground water table the 4-6 meter zone indicate the available of ground water is very high and 12-16 meter zone is indicate that the available of ground water is very low and other two zone are moderate shown in (Fig-6).

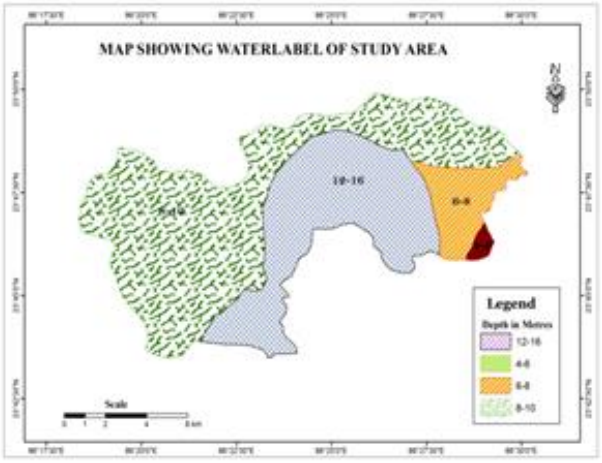

Figure 6: Ground water Level Map

VIII. CONTOUR

Contour is an imaginary line of constant elevation on the ground surface. The corresponding line on a map is called a 'contour line', a line on a map that joins places of the same elevation (height) above sea level. (Basudeb Bhatta). The contour map shown in (Fig-7) of Dhanbad block showing the highest contour vale is 260m and lowest contour value is 170m and the contour interval is 10m.

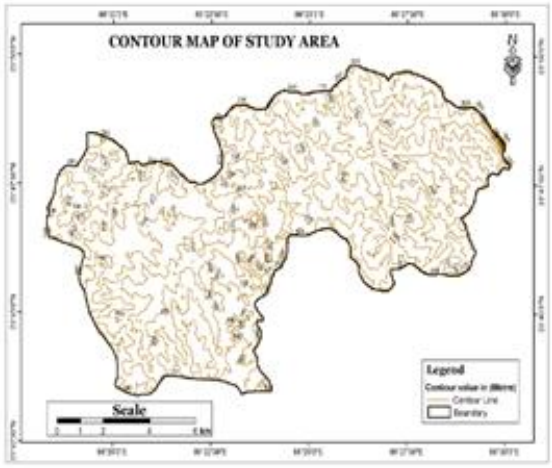

Figure 7: The Contour map of Dhanbad Block

IX. LAND USE/LAND COVER MAPPING

The Landsat ETM+ 7 of 2012 image covering the study area was classified to obtain land use – land cover for the suitable site selection for urban development planning. Satellite was clipped into ward of a block. An unsupervised classification was performed to obtain the land use/ land cover information classes into eight classes. The LU/LC map is showing (Fig-8) and (Table-1) is showing percentage of LU/LC area distribution in the study area.

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Figure 8: Land Use / Land Cover in the Study Area

SETTLEMENT: The majority of the area is under land utilization type for settlement with nearly 25% of the total area being occupied 31.01 sq.km area is cover by settlement.

VEGETATION: A vast extent of the area is found on vegetation land, nearly about 27% of the area. Under vegetation 33.22 sq. km area is covered.

AGRICULTURE LAND: 19% is kept currently for agriculture area. Agricultural land is useful for cropping and it is use full for the farmers to meet there daily life need. Agricultural land is cover 24.25 sq. km in the study area.

GRAZING LAND: 12% of the total area is under grazing land. This area is seasonally useful. In the different seasons only it is used, other days it only contains scrubs or act as a waste land. 14.52 sq. km area is covered under the total area.

MINING LAND: In study area 6% of its area is under open cast mining. Mining area is a conserved 7.78 sq km.

WASTE LAND: Waste land is about 2% in the study area 2.99 sq km.

WATER BODY: The inland water body cover 1.29 kq km about 1% of total study area.

RIVER: River and waster bodies both contain only 1% of the study area 0.52 sq km.

BARREN LAND: Mostly barren land area of 8%. They appear very distinctly on the satellite data. Nearly a quarter of the area is under 10.23 sq km.

Sl. No.	Class Name	Area (in sq km)	Area in %
1	Settlement	31.01939	25
2	Vegetation	33.22035	26
3	Agricultural land	24.2552	19
4	Grazing land	14.52511	12
5	Mining land	7.78883	6
6	Waste land	2.99025	2
7	Water bodies	1.2969	1
8	Barren land	10.23614	8
9	River	0.522235	1
Total area		125.85	100

Table 1: LU / LC Area in the Dhanbad block

X. GEOLOGY FEATURES

From geological point view study area can be divided into four parts (Fig-9) (i) northern part consists with Barakar formation are consist with white to buff colour coarse medium sandstone and grit shale, (ii) Barren measure rang is the main geological formation of the lower part of the study area (iii) Talchir formation is formed due to the mass flow of sediments and minerals (iv) Upper middle portion approximate half of the are covered by gneiss and schist (Archean Formation). Strictly speaking there are no large stretches of what may be called as plains in this Basin area.

Figure 9: Geology Map of the Study Area

XI. SOIL

Soils are complex mixtures of minerals, water, air, organic matter, and countless organisms that are the decaying remains of once-living things. It forms at the surface of land – it is the "skin of the earth."(ICAR). The (Fig-10) map represents the study area soil feature which is under 80 & 82 soil categories. So 80 is a fine loamy, mixed, hyperthermia Typic Haplustalfs Loamy, mixed, hypothermic Lithic Ustorthents, Area (hect) is 467, and % of TGL is 22.39 and 82 is a Fine loamy, mixed, hypothermic Typic Haplustalfs Fine, mixed, hypothermic Aeric Endoaqualfs, Area (hect) 609, and % of TGL is 29.20.

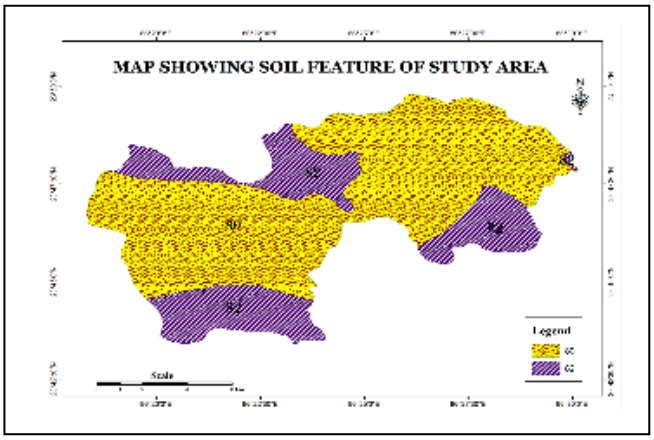

Figure 10: Soil Map of the Study Area

XII. DATA USED

Landsat ETM + 7 satellite image, DEM image, Topographical map of 1987, Soil map, Ground water label map, geology map. In this study the secondary data has been collected from various sources, Non spatial data are collected from different government office i.e. Anchal map, population census data.

XIII. METHODOLOGY

Various important factors relevant for Dhanbad block study area such as present land Use/Land Cover, proximity to river and drainage, water label, soil texture, geology feature, and population pressure are chosen so as to keep the model compact and effective. These factor vector layers are converted to raster layer, then reclassifying the entire raster layer and are weighted according to the weighted method by creating a separate field in each layer. Each class or category in each layer is given weighted value or rank and these value or ranks are stored in the database as separate field. And also the product of weight and rank are computed and stored in another filed. Finally all the reclassified layers are combined together by applying Weighted Overlay operation on all layers at a time. Thus totally weighted value is carried out to reclassified layers to get the final weighted combined factor reclassified layer. Ultimately the Weighted Overlay of the factor maps and gives site suitability for urban development. The final parcel urban land suitability map for future urban planning is created to achieve maximum accuracy keeping in mind the parcel level land suitability analysis.

XIV. PROXIMITY ANALYSIS

One of the popular proximity analyses is based on buffering; Buffer can be defined as an influenced area or zone of an object in GIS. Proximity analysis is not always based on distance but also on time, as it is known that distance can be converted into time. (Basudeb Bhatta).

A. SETTLEMENT

In the above map (Fig-11), red colour is showing a settlement area in which we had created a single buffer ring around the settlement area about 100 m, so that the area within the range of 100 m no roads or railway track will be constructed. Also the other construction should not be done which is harmful for the settlement area. Hence light brown colour showing around the settlement is the buffer zone.

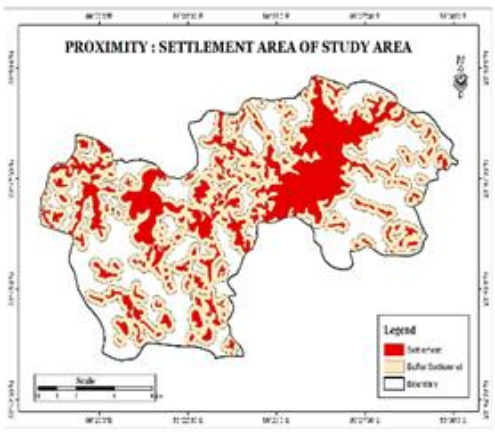

Figure 11: Distance from Settlement

B. ROAD & RAIL NETWORK

The Road & railway network buffer map is showing (Fig-12) the single buffer ring created around the roads and railways about 100m, so that the restricted zone is created around the road and railway track and no other construction should be place within 100 m range and avoiding accidents as much as we could.

Figure 12: Distance from Road and Railway

C. RIVER & DRAINAGE

From the proximity of river and drainage map we can conclude that the area covered by river and drainage should be conserved as much as we could. River and drainage is the major source of water. It is the lifeline for agriculture farming and many more. Hence within the range of 100 m buffer zone nothing should be constructed and also take care about to preserve them. The buffer created about 100m around the river and drainage map is shown in (Fig-13).

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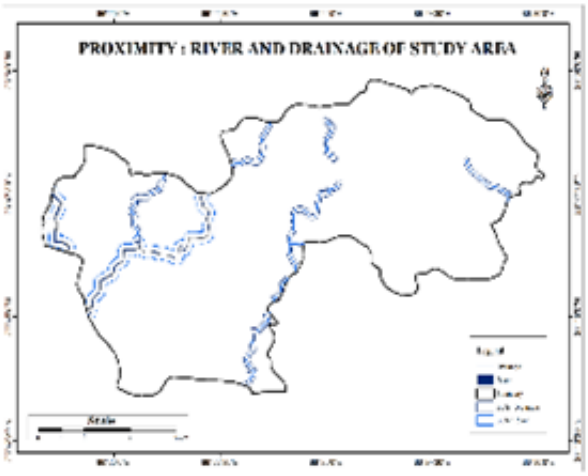

Figure 13: Distance from River & Drainage

D. SURFACE WATER BODY

Single buffer ring is created about 100m around the water bodies of the study area. Water bodies are very important for rural areas population as well as urban areas. They are mainly depended on a water bodies for bathing, washing cloths and many more. Water bodies is also used for the storage of rainfall water which can be useful in the other days of life and that's why the area within the range of 100m of water bodies nothing should be constructed so that the water bodies is not polluted and keep safe and conserved. Buffer zone around water bodies is shown in (Fig-14).

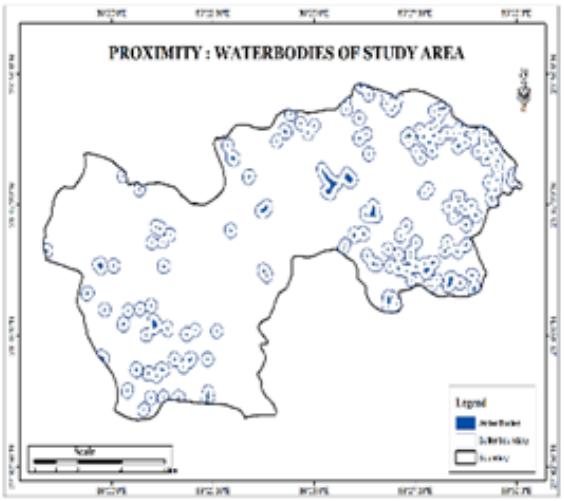

Figure 14: Distance from Surface water body

XV. RESULTS

A. SUITABLE SITE FOR SUSTAINABLE URBAN DEVELOPMENT

The final map shown in (Fig-15), is Suitable site selection for urban development map prepare using weighted overlay analysis method with the help of different thematic layer. From the above final result map, It is shows that the area having red colour in the study area are restricted for the future urban development planning as there is a huge settlement, lack of surface water bodies and also the population pressure is high. Whereas the light yellow colour area shows the suitable site for the urban development planning as there is less settlement in comparison to the red colour zone area, population pressure is less and moderate amount of surface water bodies are present. Finally the dark green colour area zone which is mainly in the western part of the study area like Ganshadih, Jatudih, Jharma, Sabaldih, Rajesh Bera, Kustuk, Brlihahi, Kusunda, Phutha, Dhabanil, Basuria, Ekra, Goreria, and also other some part of Nawadih, Dhansar, Bera, Narayanpur Dhariojoba, Godhar, Chirudih and Samshikhary of the study area which are the highly suitable site for the future urban development planning. Mainly all the feature are present in this area which make these areas as suitable site for the urban development planning like available of surface water bodies, road communication, available of vegetation for giving healthy environment, Ground water label is mainly nearer in the selected site. The below (Table-2) shows the weight value to different feature as per the requirement to fulfil in the suitable site selection for the sustainable urban development planning.

Feature	Class name	Class weighted	Theme weighted
Water label	4m-6m	8	25
	6m-8m	7	
	8m-10m	5	
	12m-16m	5	
Soil profile	80	9	15
	82	6	
Population pressure	13 – 733	5	12
	734 – 1392	3	
	1393 – 3201	2	
	3202 – 7011	1	
	7012 - 18709	1	
Geology	Archean Formation	1	15
	Barakar formation	6	
	Barren measure	6	
	Talchir formation	2	
Land Use/Land Cover	Water bodies	7	33
	Waste land	2	
	Barren land	3	
	Vegetation land	4	
	Agricultural land	6	
	Settlement area	2	
	Mining	2	

	Grazing land	3	
	Road	4	

Table 2: Weighted Value of Class Features

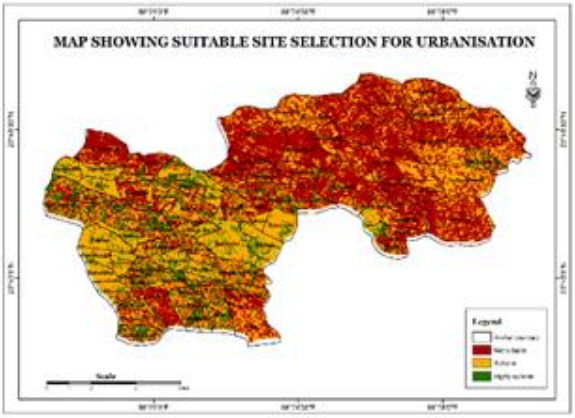

Figure 15: Suitable Site for Sustainable Urban Development

XVI. CONCLUSIONS

The present study demonstrated the efficiency of Geoinformatics as a tool in the study of land use /land cover changes. To fight with the problems faced by the rapid urban growth, various scientific perspectives are necessary for a holistic assessment of urban situations. The major problems associated with the urban centres in India are that of unplanned expansion, changing land use / land cover areas. For this, remote sensing imagery, with its repetitive and synoptic viewing capabilities, together with GIS, is important tools to map areas and monitor the changes in the urban growth. This work focused on the multi-scale approach with remote sensing, to support urban management with area-wide and up-to-date datasets. The Landsat data analysis able the monitoring of the classification overtime to understand the dynamics and characteristics of the area of Dhanbad block. This includes also information about the direction of urban planning. Thus, remote sensing and GIS provided to be a very useful basis for a more detailed analysis of the spatial distribution, an emerging megacity which is prerequisite for a reasonable planning of technical infrastructure. The officials of various government departments should be given through exposure and training of remote sensing and GIS for its application implementation in the urban development plans. This multilayer spatial information allows analysing and anticipating developments to support future planning strategies. The study investigated the urban development planning phenomenon occurring in the Block and Nagarnigam area and found that there has been an overall Settlement area is 25% in 2011. Based on the analysis and overall data we can conclude that,

- ✓ In the study area overall area is covered with settlement and vegetation i.e. about 25% area is under settlement and 27% is under vegetation.
- ✓ Dhanbad administrative ward shows the population pressure which is largely present in the area Bhuli, Dhanbad, Hirapur, Godhar, loyabad, chota putki, Pandar Kanale, Jagigora, Nichitpur, Sendra, Sijua, and Bherhnpur.
- ✓ Dhanbad is also known as mining area, but in the study area only 6% are under open cast mining. Hence in this area only few chances for the sustainable urban development.

All the features were present on the suitable site selection for the urban development planning i.e. low population pressure, having surface water bodies, suitable geology conditions, and low ground water label.

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