RESEARCH ARTICLE OPEN ACCESS

Identification and Evaluation of New Industrial Zones in Giridih District using Remote Sensing & GIS Techniques

Ahmed Mohamed Abushnafa[1] , R. K. Pandeyb[2] , Deepak Lalc[3]

[1](Department of Civil Engineering, Sam Higginbotom Institute of Agriculture Technology & Sciences,)

[2](Department of Civil Engineering, Sam Higginbotom Institute of Agriculture Technology & Sciences)

[3](Department of Soil Water, Land Engineering and Management, Sam Higginbotom Institute of Agriculture Technology & Science)

Abstract:

This study was carried out to identify suitable sites for Industrial development at Giridih District in Jharkhand state using GIS-based multi-criteria evaluation (MCE) such as landuse/landcover, groundwater, geomorphology, slope, road proximity, rail proximity, river proximity factors. High resolution spatial data (Landsat7 ETM+) and seven thematic information layers were analyzed using ArcGIS 9.3 and ERDAS Imagine 9.2 softwares to identify suitable areas for establishing an industry in Giridhi District. The entire study focuses on GIS based Overlay Weight Ages. In this study landuse/landcover, groundwater, geomorphology, slope, road proximity, rail proximity, river proximity are the factors that were identified for the multi-criteria evaluation. Various thematic maps were generated using visual interpretation of Landsat7 ETM+ satellite data for every variable showing site suitability measured on a size of 1-10. Weights for every criterion are created by contrasting with one another based on their significance. The final suitability map was obtained using weighted overlay techniques and Spatial Analyst Tool. Outcome generated through the GIS analysis shows that 160.85 km2 areas is very highly suitable, 407.85 km2 area is moderately suitable; 4398.30 km2 area is less suitable, for industrial development.

Keywords — **Industrial, suitable site, Remote Sensing, GIS.**

I. INTRODUCTION

One of the key factors is to start-up a process and expands or reallocate of all kinds of business is identifying a best suitable site for that business, the success or failure of the establishment of an industrial system depends on the site selection acts, the main objective in industrial site selection is to find the most suitable site with all the desired conditions satisfied defined by the selection criteria. Geographical data is used in industrial site selection by decision makers and managers which concludes that industrial site selection process is spatial decision problem and GIS has been identified as a decision making tool. Geographic information systems (GIS) has been identified as a powerful tool for performing spatial analysis to store, capture, display, query, analyze and output geographic information,GIS has been used for the site suitability analysis for an Industrial development in Giridhi District in Jharkhand.

This paper presents a powerful solution for spatial decision support, the current study focuses suitable site offering of industrial development depending on multi-criteria decision analysis and geographic information system based (GIS) overlay analysis the most suitable site for industrial development in study area. Thematic maps on the selected criteria were developed from the paradigm of typical GIS software, thereafter; weightings were assigned to each criterion dependant on their ratings and relative importance in accordance with the relative magnitude of impact. A GIS-based overlay examination was performed to identify the suitable site for the industrial development. [1]

Major developments are now taking place in the integration of remote sensing data and GIS due to the increased demand for the spatial information. There are three main ways in which remote sensing and GIS technologies are complementary to each other a) Remote sensing can be used as a tool to gather data sets for use in GIS; b) GIS datasets can be used as ancillary information to improve products derived from remote sensing and c) RS data and GIS data can be used together in resource analysis and modeling. The integration of RS and GIS known as Geo-spatial analysis is crucial tool for the resources manager to challenges face in twenty first century. It allows us as resource managers to develop, analyze, and display spatially explicit to deal with larger spatial scales such as regional landscapes.[2]

1.1 *Objectives*

1. Generate various thematic maps (geomorphology, ground water, slope, road, rail, and river) for assessing the land use and availability of other resources necessary for setting up an industry in Giridih District.
2. To identify and locate a suitable site using multi criteria approach for setting up an industry in Giridih District.

II. MATERIALS AND METHODS

2.1 Study Area

Giridih is located at 24.18°N 86.3°E. with an

Average elevation of 289 meters (948 ft) it is bounded by Jamui in the north ,Bokaro and Dhanbad in the south Deghar and Jamtara in the east and Kodarma and Hazaribag in the west. Giridih District is geographically divided into two natural divisions, which are the central plateau and lower plateau. The central plateau touches the western portion of the district near Bagodar block. The lower plateaus have an undulating surface and an average height of 1300 feet. In the north and north-west, the lower plateaus form fairly level tablelands until they reach the ghats when they drop to about 700 feet. Giridih district is divided into two main water heads – Barakar and Usri rivers. Giridih is rich in mineral resources and has several large coal fields with one of the best qualities of metallurgical coal in India. Mica is found in abundance near the blocks Tisri and Gawan. Mica is of importance not only to Jharkhand but to India and other countries as well. [2].

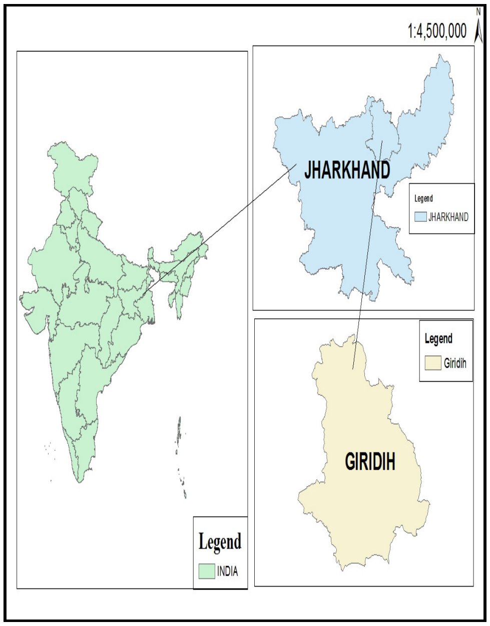

Fig 1: study area

2.1.1 *Economy*

This town used to bustle with economic activity in the period from 60s to 80's when the mineral mica processing and export community reaped tremendous gains through exports to the USSR. Since the decline of the USSR however and its split into twelve CIS countries, the industry has slowly declined and is currently ailing. On the southern side of Giridih, in Beniadih, are the coal mines of Central Coalfields Limited, a subsidiary of Coal India Limited (a Navratna and the world's largest coal miner). It is the largest industry in the Giridih district and major contributor to the economy of the town. Central Coalfields Limited itself is a Miniratna. The Data Processing Center of Data Processing Division (DPD) of National Sample Survey Organization (NSSO) provides complete IT solution from sample selection, software development to processing and tabulation of data canvassed through various socio-economic surveys of National Sample Survey Organization. [4]

2.1.2 *Availability of Minerals:*

The main mineral of the district is Coal. However Building Stone, Sand Stone, Quartz & Red Bricks are also minerals and mining of this district. [5] Minerals present in the Giridih district is shown in

Table 1

Table 1 production of mineral 2010-11 source: district mining office, giridih

Name of mineral	Production (in tons)
Coal	5,81,361MT
Building Stone	1,94,823MT
Sand Stone	25,000M^3
Quartz	12,477MT
Chemney Bricks	30,00,000
Mica	Not available
Sand	Not available
Red Bricks	Not available

2.1.4 *Software's Used*

1. ArcGIS Desktop 9.3
2. ERDAS Imagine 9.2

2.1.5 Data used

Table 2:SatelliteData

Remote sensing data	Landsat satellite data
Sensor	Enhanced thematic mapper plus (ETM)
Temporal resolution	16 days
Spatial resolution	30m* 30m
Spectral range	0.45 – 12.5μm
Image size	183 km * 170 km
Sensor type	Opto-mechanical
No. of bands	8
Swath	183 km

Table3. Toposheet Data

SOI Map No.	Scale	Purpose
72H, 72L, 72E,73I	1:250,000	Geo-referencing of satellite data, Study area boundary extraction
72H/12, 72H/13, 72H/14,72L/1, 72L/2,L72/3, 72E/13, 73I/1,73I/5	1:50,000	Ground truth & mapping

2.1.3 Potential for new mineral based industry

Purpose , Fly Ash Bricks , Mica Paper, Stone Chip Mineral Grinding ,Quartz Grinding & Calcinations, Chimney Bricks , Mica Powder, De-Hydrated Lime, Refractory Bricks Mineral Based:- Hard Coke , Soft Coke for Cooking.

2.2 Methodology

The methodology for locating the best Industrial site in Giridhi District, for each and use activity is guided by the intent to minimize the possible adverse effects of development on the environment and on existing communities, and to emphasize the positive impacts of such development, by locating them in a most suitable location The best Industrial site in Giridhi District is achieved by examining a number of Criterion, assigning them a scale of 1-10 as per the order of importance to identify the most suitable location. By adopting this site suitability method, One can identify the considered criteria systematically and analyze the net outcome as the best suitable site using a Geographic Information System.By revising the relative importance to identified criteria based upon the particular land use under consideration, it is possible to generate "suitability maps" for each individual land use, and then generate a final composite land use that is based on a best possible collective suitability of multiple land uses To achieve this, all the criteria are assigned a "rank" denoting their relative levels of importance within the suitability study. These ranks are assigned as numeric values ranging from 1 to 10, with 1 reflecting a low level of importance and 10 reflecting a high level of importance. Using Weighted Overlay techniques in ArcGIS Software, We have overlayed all the prepared thematic layers like landuse/landcover, groundwater, geomorphology, slope, road proximity, rail proximity, river proximity with all weightages, We have identified the best suitable site for industrial development in Giridhi District.[6]

2.2.1 Weighted Overlay

The Weighted Overlay tool applies one of the most used approaches for overlay analysis to solve multi-criteria problems such as site selection and suitability models. In a weighted overlay analysis, each of the general overlay analysis steps are followed. "Since the input criteria layers will be in different numberingsystems with different ranges, to combine them in a single analysis, each cell for each criterion must be reclassified into a common preference scale such as 1 to 10, with 10 being the most favorable. Each of the criteria in the weighted overlay analysis may not be equal in importance. You can weigh the important criteria more than the other criteria" [7]. The input criteria are multiplied by the weights and then added together

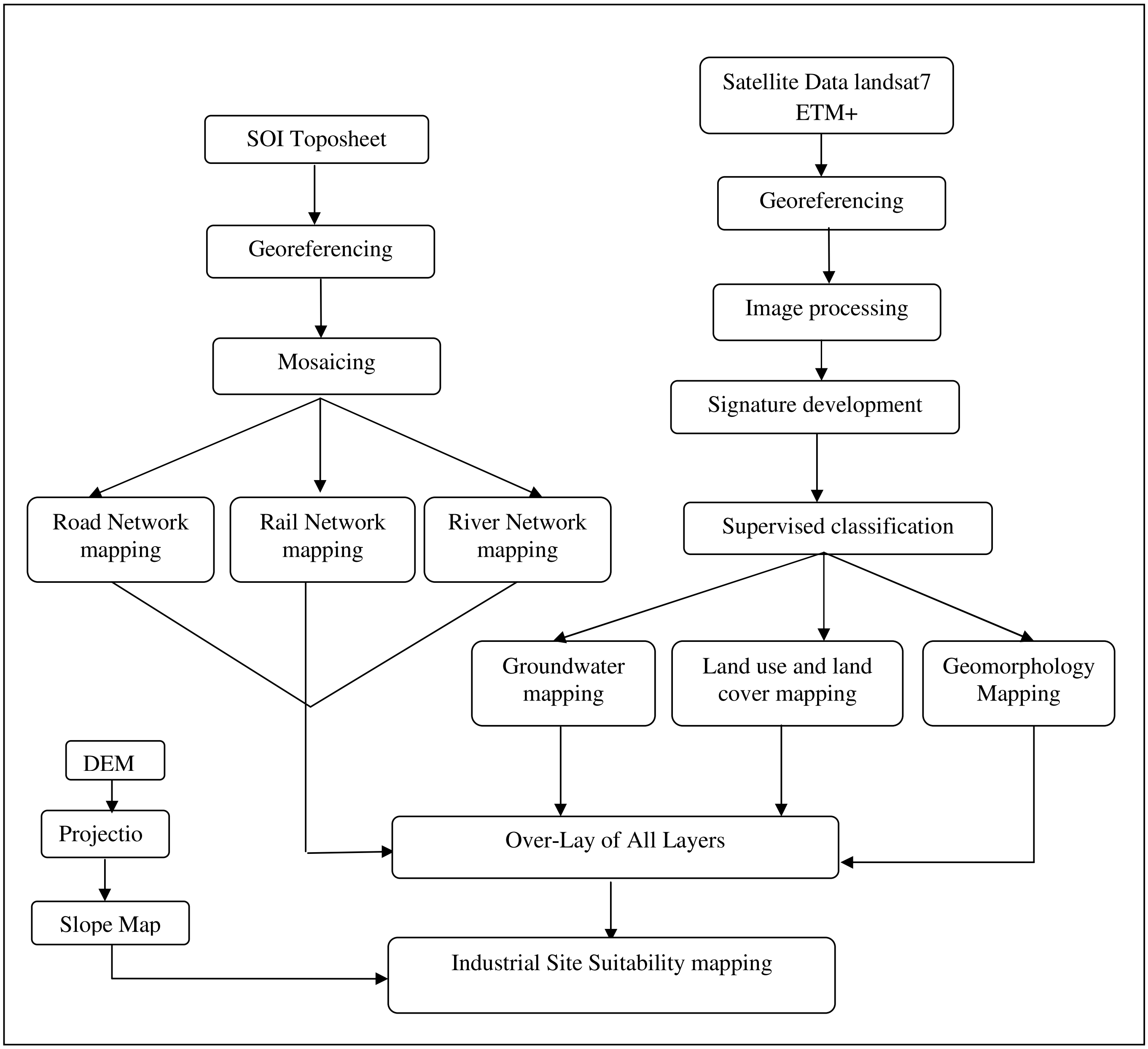

Fig 2: methodology of research

III. RESULT AND DISCUISON

3.1 Land use / land cover Map

Table 3.1 weightage for land use and land cover map

Land use land cover classes	Area (km^2)	Area (%)	Suitability score
Agriculture Land Crop Land –Kharif crop	1981.99	39.89	4
Agriculture Land Crop Land More than two crop	0.0529	0.001	4
Agriculture land crop land Rabi crop	98.52	1.98	4
Agriculture Land Crop Land Two crop area	127.07	2.56	4
Agriculture Land- Fallow- Current Fallow	555.97	11.19	4
Build- up land (Rural)	242.01	4.87	5
Buildup-(Urban)-Mixed build up area	9.9088	0.20	3
Buildup-(Urban)-Vegetated Area	0.9636	0.02	2
Buildup-Mining/Industrial Area-Ash/Cooling/Tailing	0.175	0.001	1
Built Up-Mining /Industrial Area-Mine/Quarry	14.74	0.30	1
Forest – Scrub Forest	399.16	8.03	2
Forest Deciduous (Dry/Moist/Thorn)- Open	369.85	7.44	2
Forest Deciduous(Dry/Most/Thorn-Dense)	532.13	10.71	2
Tree Clad Area	13.95	0.28	1
Wasteland- Barren Rock/Stony waste	198.284	3.99	8
Wasteland- Scrub land –open scrub	319.46	6.43	8
Wasteland-Gullied/Ravinous land –Shallow ravenous	0.1288	0.003	8
Wasteland-Scrub land Dense scrub	12.93	0.26	8
Water bodies –Lakes/Ponds-Dry- Kharif extent	9.02	0.18	1
Water bodies-Lakes/ponds-Dry-Rabi extent	1.51	0.03	1
Water bodies-River/Stream-Dry	31.52	0.63	1
Water bodies-River/Stream-Perennial	49.27	0.99	1
Water bodies-Reservoir/Tanks-Dry Kharif extent	0.0039	0.001	1
Total	4968.65	100	

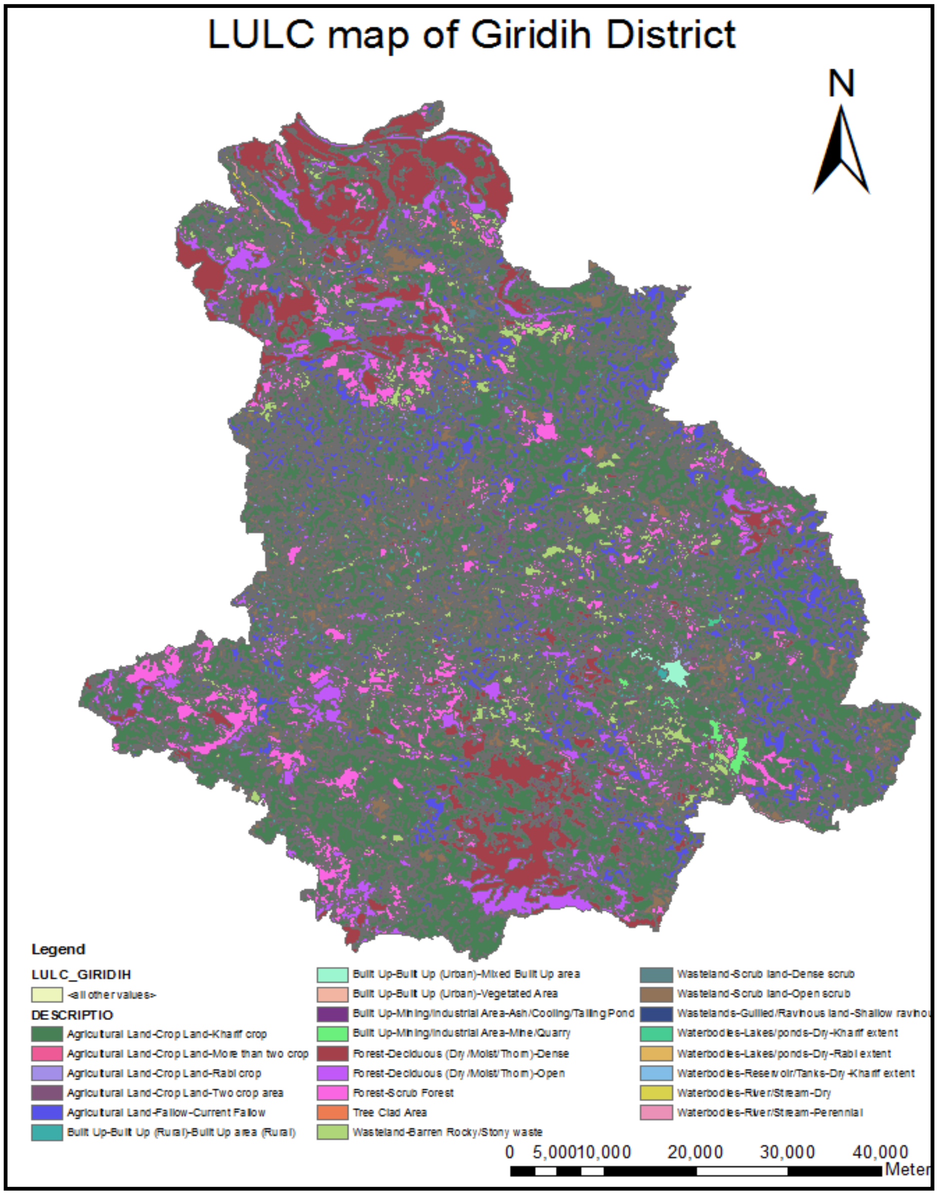

Fig 3.1: LULC Map

3.2 Geomorphology Map

Table 3.2 weightage for geomorphology map

Classes	Area (km2)	Area (%)	Suitability score
Alluvial plain gullied	2.72	0.054765	8
Alluvial plain moderate (5-20M)	40.01	0.805562	9
Alluvial plain shallow (<5M)	82.11	1.653204	10
Buried channel	1.66	0.033422	4
Channel Bar	0.166	0.003342	1
Denudational hill	271.35	5.463364	3
Dyke Ridge	0.131	0.002638	3
Fracture Line valley	2.47	0.049731	2
Hill top weathered	9.69	0.195099	2
Inselberg	14.33	0.28852	2
Intermontane valley	40.47	0.814823	6
Linear ridge	16.27	0.32758	2
Mesa	2.94	0.059194	2
Oxbow lake	0.12	0.002416	1
Pediment	29.64	0.596772	3
Pediment-inselberg complex	380.135	7.653643	4
Pediplain shallow weathered (<5M)	5.51	0.110938	4
Plateau – Gullied	33.50	0.674489	7
Plateau Moderate Dissected	61.12	1.230591	7
Plateau slightly dissected	2.86	0.057583	8
Plateau weathered moderate (5-20M)	2051.25	41.29989	7
Plateau weather shallow(<5M)	1232.61	24.81738	7
Point bar	2.02	0.040671	1
Quartz Reff	3.15	0.063422	2
Residual Hill	22.79	0.458854	2
River/Water Body	31.95	0.643282	0
River Sand	60.44	1.2169	0
Shear Zone	1.25	0.025168	1
Structural Hill	277.30	5.583162	1
Valley Fill Shallow (<5M)	286.76	5.773629	4
Total	4966.72km2	100	

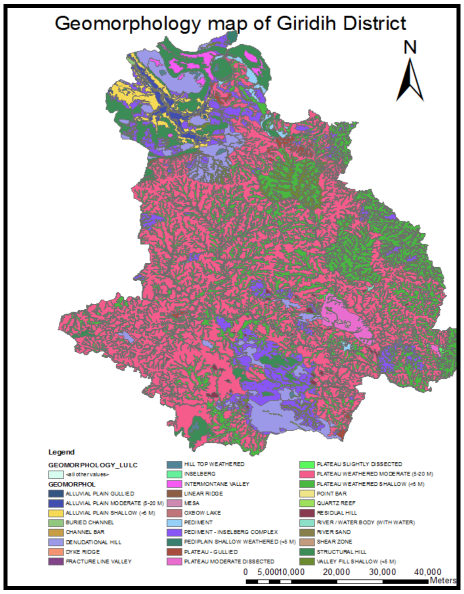

Fig 3.2 Geomorphology map

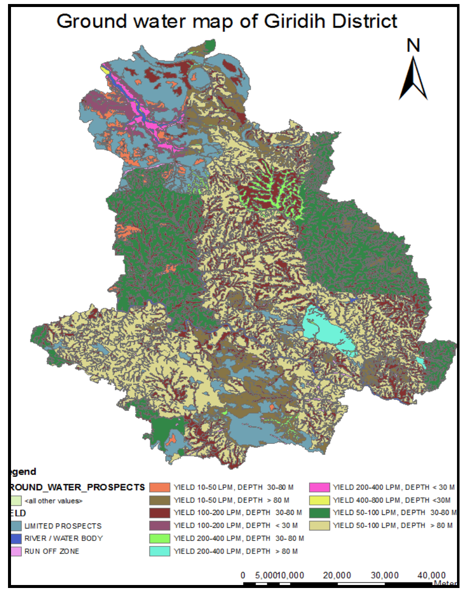

Fig 3.3 Groundwater map

3.3 Ground Water Map

Table 3.3 weightage for groundwater map

Classes	Area (km2)	Area (%)	Suitable score
River/Water Body	92.39	1.86	0
Run off Zone	35.12	0.71	1
Yield 400-800 LPM, Depth< 30m	3.84	0.08.	10
Yield 200-400 LPM, Depth < 30m	40.01	0.81	8
Yield 200-400 LPM, Depth 30-80m	102.45	2.06	7
Yield 200-400 LPM, Depth>80m	65.83	1.33	4
Yield 100-200 LPM, Depth<30m	81.25	1.64	6
Yield 100-200 LPM, Depth 30-80m	1207.15	24.30	7
Limited Prospects	571.44	11.51	5
Yield 50-100 LPM, Depth 30-80m	863.95	17.39	6
Yield 50-100 LPM, Depth>80m	1449.10	29.18	3
Yield 10-50 LPM, Depth 30-80m	83.22	1.68	2
Yield 10-50 LPM, Depth>80m	370.94	7.47	0
Total	4966.69	100	

3.4 Slope Map

The aim of this study is to utilize the remotely sensed data and GIS techniques for slope assessment for site suitability of Industry setup at Giridih district. DEM is used to classified the area in 16 slope classes (slope in degree) and then weightage is assigned which is shown in the table 3.4 and fig 3.4

Table 3.4 weightage for slope map

Slope classes (degree)	Weightage
0-4	10
4-8	8
8-12	7
12-16	6
16-20	4
20-24	3
24-28	2
28-32	1
32-36	1
36-40	1

40-44	1
44-48	1
48-52	1
52-56	1
56-60	1

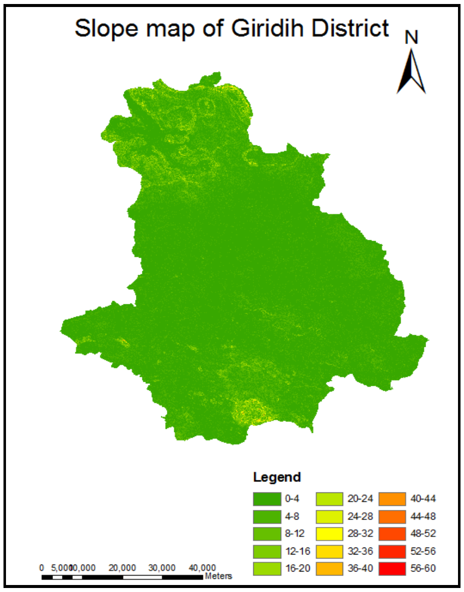

Fig 3.4: slope map

3.5 Road Map

The Road network was prepared from toposheet map. Considering the road network five buffer zone was created which is shown in figure 4.5. This buffer zone helps to find out the site for industry development where road network is existing.

Table 3.5: weightage for Road Map

Roads Distance(In meters)	Suitability score
0-200	8
0-400	7
0-600	6
0-800	5
0-1000	4

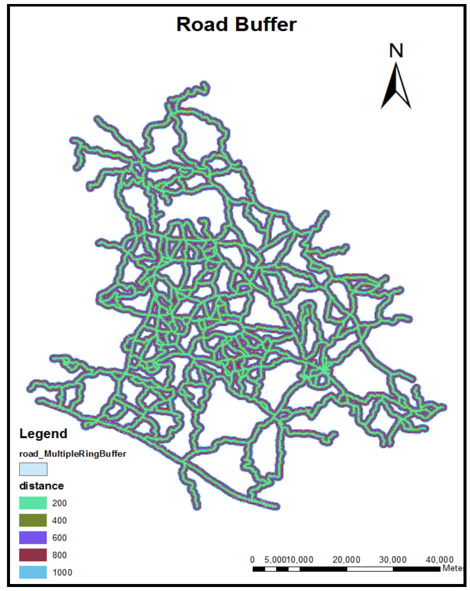

Fig 3.5: Road Map

3.6 Rail Map

The rail network was prepared from topographic map. Considering the rail network five buffer zone was created which is shown in figure 4.6. this buffer zone helps tofind out the site for industry development where rail network existing

Table 3.7 :weighage for Rail Map

Rail Distance(in Meters)	Suitability score
0-1000	1
0-2000	2
0-3000	5
0-4000	7
0-5000	10

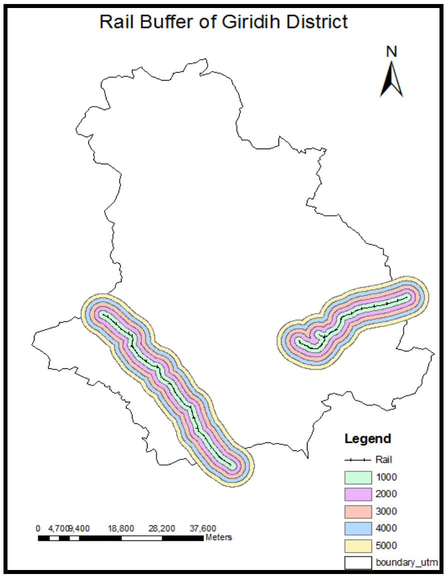

Fig 3.6: Rail Map

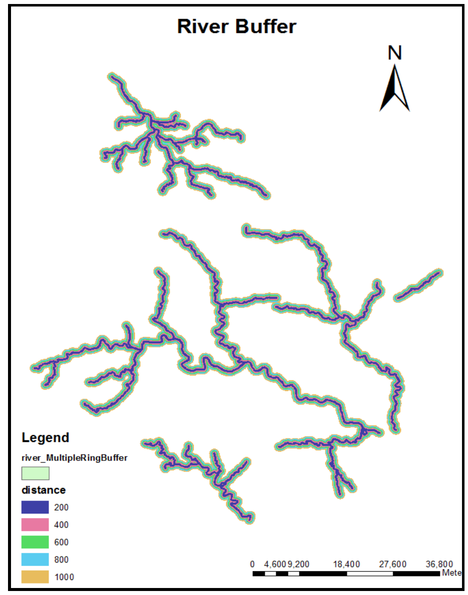

Fig 3.6: River Map

3.7 River Map

The river map was created from the topographic map. Four buffer zone was created which is shown in the figure 4.7.

Table 3.6 weightage for rail map

River Distance(in Meters)	Suitability score
0-200	1
0-400	1
0-600	6
0-800	8
0-1000	10

3.8 Suitable site mapping

Maps like land use land cover, geomorphology, ground water zone, distance buffer from major roads, distance buffer from major river, slope map, and their suitability scores are given in the figures 3.1,3.2,3.3,3.4,3.5,3.6,3.7 and tables 3.1, 3.2, 3.3, 3.4, 3.5, 3.6, 3.7 respectively. raster datasets for different layers having different score were overlayed and the scores of each After projection and topology creation all feature classes like geomorphology, ground water, slope railway network, river and road were converted to raster files and separate datasets were created using weightage and rank. For the analysis all the

composite class were added using raster Calculator tool of spatial analyst extension of Arc GIS 9.3. the final score were reclassified to generate the output map showing various classes of suitable site for industrial development. After the analysis of using all thematic layer total area in our study including 4966 Km^2. The results show that 160.85 km^2 areas are highly suitable, 407.85 km^2 areas is moderately suitable, 4398.30 km^2 area is less suitable. Suitable area obtained in the analysis is shown in the table 3.8 and the suitability map is shown in the figure 3.8 Sevensites were selected as the high suitable industry setup site distributed throughout the study area. Location of all seven places is shown in table 3.9. These areas are either Wasteland, Scrub land, Open scrub, Barren Rocky and Stony waste all the seven sites are very close to main road and connected to branch road.

Table 3.8 high, Moderate and Less Suitable areas for Industrial site Selection

Class	Area Covered (Sq km)
Highly Suitable	160.85
Moderately suitable	407.85
Less Suitable	4398.30

Table 3.9: Identified industrial sites in giridih district, Jharkhand

	Location	Geomorphology	Land cover types	Ground water	Distance from main road(m)	Distance from river	Area (sq km)
Site1	86°0'3.53"E 24°38'35.924 "N	PLATEAU WEATHERED MODERATE (5-20 M)	Wasteland-Scrub land-Open scrub	Yield 100-200 LPM, Depth<30m	0-200	0-800	0.818177
Site 2	85°54'25.403 "E 24°20'48.5"N	PLATEAU WEATHERED MODERATE (5-20 M)	Wasteland-Scrub land-Open scrub	Yield 50-100 LPM, Depth 30-80m	0-200	0-1000	0.615
Site3	86°19'1.803" E 24°2'38.567" N	PLATEAU WEATHERED MODERATE (5-20 M)	Wasteland-Barren Rocky/Stony waste	Yield 200-400 LPM, Depth 30-80m	0-200	0-1000	0.815903
Site 4	86°18'47.078 "E 24°18'25.096 "N	PLATEAU WEATHERED SHALLOW (<5 M)	Wasteland-Barren Rocky/Stony waste	Yield 100-200 LPM, Depth<30m	0-200	0-800	0.087538
Site 5	86°4'16.722" E 24°26'16.444 "N	PLATEAU WEATHERED MODERATE (5-20 M)	Wasteland-Scrub land-Open scrub	Yield 400-800 LPM, Depth< 30m	200-400	0-1000	16.1385
Site 6	86°7'54.273" E 24°10'23.888 "N	PLATEAU WEATHERED MODERATE (5-20 M)	Wasteland-Barren Rocky/Stony waste	Yield 200-400 LPM, Depth 30-80m	0-200	0-1000	0.815903
Site 7	86°3'27.276" E 24°18'23.911 "N	PLATEAU WEATHERED MODERATE (5-20 M)	Wasteland-Scrub land-Open scrub	Yield 400-800 LPM, Depth< 30m	200-400	0-800	0.818177

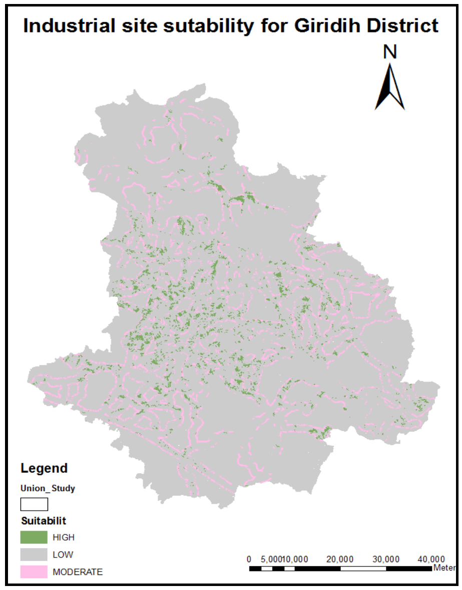

Fig 3.8: Identified industrial sites in Giridih district, Jharkhand

IV. Conclusion

Satellite remote sensing offers opportunity to obtain current information over large areas and GIS can be utilized to further analyze this information through simple models to answer the specific questions.

1. Giridih is one of the leading mineral producing states in the country and occupies

2. Remote Sensing and GIS has been used to assess the LULC in spatial and temporal domain. This has been illustrated in the present study particularly in view of examines an approach for identifying the new industrial zone.

unique position in mineral production and mineral based industries. The mines areas are going to increase in near future. At the same time this area is also highly dominated by forest resources. The complex environmental matrix, large scale mining and industrial activities, huge mineral resources still available and ever depleting environmental quality along with flora and fauna, has attracted attention at both national and international level.

3. Abundance of various mineral resources has led to the extensive, but haphazard quarrying activities for sustaining various industries set up in the region. Lack of sincere conservation efforts following the unplanned mineral excavation has resulted in environmental degradation. Remote

sensing data analysis in this study has helped to derive quantitative information on spatial and temporal relationships of land use/land cover and its potential sites for industry development.

4. The studies illustrate the importance of RS and GIS technology in the present days. RS

5. and GIS technology, as an information tool, has helped in the acquisition of recent land use information study aimed at solving problems. Information on different aspects for this study like land use land cover, geomorphology, Ground water, slope, road, rail, river etc has been derived using this techniques. Further integrating this data using GIS has helped in the analysis of the study, which would have been otherwise been difficult to do manually using the conventional method. The involvement of such factors or criteria requires adequate database of different dimensions. So adequate attention is required for data management to ensure the performance of the decision based methodology.

6. A multi criteria approach was employed in conjunction with GIS-based overlay analysis to identify the new industrial zone. The study was based upon a set of key criteria, which were selected based upon the already available knowledge from research literature as well as the pre-existing local level factors of the area. A set of new industrial zone were identified after subsequent screening and refinement on the basis of analysis and field check.

7. Outcome generated through the GIS analysis shows that 160.85 km^2 areas is very highly suitable, 407.85 km^2 area is moderately suitable; 4398.30 km^2 area is less suitable, for industry setup.

REFERENCE

1 Aleksandar Rikalovic*, Ilija Cosic, Djordje Lazarevic.GIS Based Multi-Criteria Analysis for Industrial Site Selection *24th DAAAM International Symposium on Intelligent Manufacturing and Automation, 2013 P r o c e d i a E n g in e e r i n g 6 9 (2 0 1 4) 1 0 5 4 – 1 0 6*

2 G. G. Wilkinson, A Review of Current Issues in the Integration of GIS and Remote Sensing Data. Geographical Information Systems *01/1996; 10(1):85-101.DOI: 10.1080/02693799608902068 Source: DBLP*

3 GIRIDIH DISTRICT, Govt of *Jharkhand*." *Assessment* And *Mapping* Of *Some Important Soil ... Parameters Including Soil Acidity* For The *State* Of *Jharkhand* (*1:50,000 Scale*). *Land Use Plan*"from Department of Agriculture, Govt. of Jharkhand. www.sameti.org/Soil_Inventory/Giridih_Soil_Analysis.

4 Giridih , Economy. *From Wikipedia, the free encyclopedia"* https://en.wikipedia.org/wiki/Giridih"

5 *Brief Industrial Profile of Giridih District*. Carried out by :-. Br. MSME-Development Institute. (Ministry of MSME, Govt. of India,). Katras Road, Matkuria, Dhanbad. *Production Of Mineral 2010-11, Source:- District Mining Office, Giridih* (Availability menials)

6 Dr Kuldeep Pareta,REMOTE SENSING AND GIS BASED SITE SUITABILITY ANALYSIS FOR TOURISM DEVELOPMENT, *nternational Journal of Advanced Research in Engineering and Applied Sciences, Vol. 2 | No. 5 | May 2013*

7 Arc GIS Resource, "How Weighted Overlay works"