Geospatial Effect on the Mining Operation in Joda/Barbil Area, ~~of~~ Odisha, India

Abstract

The Joda and Barbil mining areas in Odisha are under threat of human health, agriculture, and livelihood posing human rights violation, illegal mining, inadequate and unsafe water, air, and sanitation. Present work envisages ~~the investigation of~~ topography, soil, climate, and stratigraphy investigation ~~of the~~ area. Acquisition of Landsat 8 TIRS (Thermal Infrared) and, Landsat 5

TM (Thematic Mapper), and CARTOSAT DEM data of temporal and spatial satellite images from various websites. ARC GIS and ERDAS IMAGINE 9.2 software used to find the land use and land cover images (accuracy average 90%),~~ and~~ Normalized Difference Vegetation Index (NDVI) estimation~~ of Normalized Difference Vegetation Index (NDVI)~~, ~~and~~ Surface air Temperature (SAT) of Barbil area for 2003, 2007,

2017 and 2018. ~~On comparison of t~~The ~~various~~ results shown that, there is increase in built up area, and mining areas whereas the agricultural land and vegetation cover. There is constant SAT rise of 1-2$^{\circ 0}$ C in all land cover classification between 2007 and 2018. The NDVI values show conversion of sparse from dense vegetation in the area. Poor operational strategies in mines –operation, –corruption, illegal mining, lack of accountability, overburden wastes/ trailing, ecologic degradation, waterlogging in mine pits, ~~illegal mining,~~ and human rights violations are the causes. It is pertinent to implement strictly Mines and Minerals (Development and Regulation) Amendment Act, India, 2021, regular seizes, GIS application to assess mines volume~~ of mines~~, to have strict vigilance and accountability for losses of existing mines, and afforestation/–reforestation of degraded/lost forests in Barbil area.

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Keywords: GIS studies, LU/LC, Mining areas, SAT, NDVI, Illegal Mining,

Introduction:

Improper and irregular mining in Odisha has posed threats to sustainable standards in water, air, land, forests, health and safety. The western Odisha has bountiful mineral possessions in rural locations, typically deprived of occupation and unpredictable cultivation and distracted livelihood. Mining activities has up surged jobs, and economic expansion, but imposes substantial health and sustainable issues. From 1980, the mining exploration as a hub has exceeded expectations and have lost its past green corridor serving mostly to its ethnic aboriginals in past.

The major iron ore potential mining ~~potential of iron ore~~ in the Keonjhar district in Odisha is about

3142.70MMT, available in Joda, Mahalapat, Tiring Pahad, Sidhmath, Banspani, Thakurani, and Gandhamardan Hills *etc.* The minor minerals like ~~M~~manganese o~~O~~res are accessible of quantity >20MMT at Barbil, Koida, Joda, Bhadrasahi, Kalimati etc., (DSR Keonjhar 2018[1]).The mining accomplishments in Barbil, Odisha is creating poor human health, agriculture, and distorting livelihood of its aboriginal people. They pose irregularities like human rights violation, illegal mining, inadequate safe water, air, and sanitation. Lack of governance, lag in complying basic indicator, corruption, poor health standards breeching social and economic obligations, **Fig 1.**

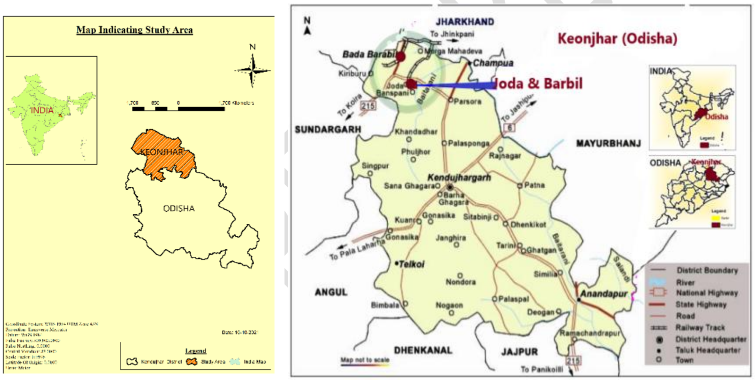

Fig 1: Index map of Study area in Keonjhar district Odisha.

As per government data the district Keonjhar has lost 104.51Km^2 of its mining forest areas through 64mining projects in 38years from 1980-2017 ~~of Odisha~~. The indiscriminate mining and population surge has polluted ~~by~~ dusty air, contaminated water, deteriorated roads, polluted portable water, mining dumps, and suffering from malnutrition **(Fig 2).**

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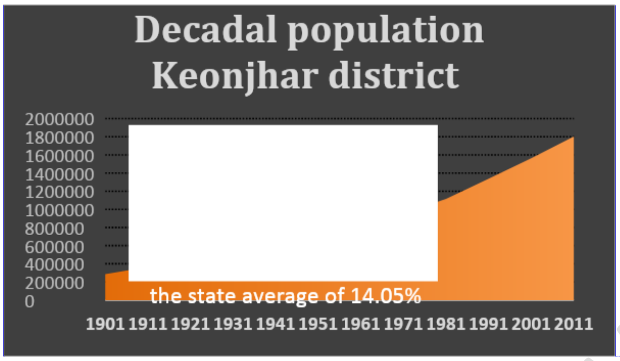

Fig 2: The decadal Population of Keonjhar District 1901 to 2011(census-2011).

The Keonjhar district has 8303 km^2 total geographical area ~~of 8303 km^2~~, 202 km^2 ~~is~~ urban and 8101

Km^2. The decennial demographic growth rate from 1971 to 81 was 16.65 percentage against the Odisha State average was 19.72 percentage. The decennial growth rate during 1981-91,

1991-2001, 2001-11 were 19.95%, 16.83%, & 15.35% respectively (2011 census[2]), **Fig 2.** This paper reveals the GIS works in the mining areas of Barbil, in Keonjhar, Odisha. Mining in Barbil, made the tribal group of the area oustees and their access to clean air, and water are found to be more vulnerable to respiratory diseases, but less vulnerable to fever. People living near the mines, are under acute prone to waterborne diseases and fever. The effect is that ~~mining growth~~mining growth needs support by cost-benefit analysis, Environmental Impact Assessment (EIA), and appropriate regulation not complying to MMDR Act, 1957 but asper Mineral Laws (Amendment) Act, 2020 *inter alia* can maintain sustained and transparent mineral production, https://thewire.in/environment/odisha-mining-tribals-access-to-air-water

Introduction and need of the study

This study is focusing on Barbil Tehsil (22.12°N & 85.40°E) hilly mining areas of average elevation (477m), Keonjhar District, Odisha with 26mines (21 mines in Joda and 05 mines in Barbil). The Joda & Barbil are both municipalities in the Barbil Tehsil having area of 275.5km^2 with 2720K population including 45% to 48% are from Scheduled Castes (SC) and Scheduled Tribes (ST). The green vegetation cover is 3097.18Km^2 (≈33. 33%) out of

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8303Km^2 of the district area grown over mines. The terrestrial setting of Barbil is Singhbhum (Jharkhand) in north, Thakurani Reserve Forest (RF) in east, Kolhabarpada,, Tanto, Fulabadi, and Sidhamatha RF in south, and the Karo River, Balagoda,, Karo RF in west.

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Chart 1: Major mines in Joda and Barbil area in force with capacity and minerals extracted.

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Name of mines	Place	Quarries in Villages	Capacity (TPA)	Mineral extracted
Mahalapat Iron ore mining Pro.	OMCL	Eastern, western, southern,& Ichinda quarry	70000	Iron
S.G.B.K. Iron & Manganese Ore Mining Proj.	OMCL	Guruda, Palsa, Siljora, Tadapani, Badakalimati, Balda, and Nayagarh	173000	Iron/Manganese
Kanther Koira Mn ore mining	M/s P M Granite Pvt Ltd	Siljora, Kalimati	20,025	73.653 H; Mn, drains pollution anticipated
Joda East iron ore mine	Tata steel Ltd, Joda	Joda, Kamarjoda, Banspani, Khuntpani& Baitarini R.F,	22.94 MTPA	671.093 ha Iron ore
Tiringpahar Iron and Mn. Mines	M/S Tata Steel LTD	Guruda, Palasa, Jadibahal, Khondbondh,Jalahari,Jajanga,	85000 (Mn)	643.71ha; Iron & Mn ore

The lapsed and rescind mines in Barbil and Joda areas are TISCO (some), Ardent Minerals and Metals Private Ltd, B.I.CO. Ltd, Bagadiya Brothers Pvt Ltd, ESSEL Mining & Industries Ltd, Feegrade & Co Pvt. Ltd, Fortune Associate Pvt. Ltd, Global Associates, Ironide Minerals Pvt. Ltd, Kaypee Enterprises, Thriveni Earthmovers Pvt. Ltd., and many others. These dead mines have not only deforested the forest areas but also dumped overburdens, wastes and trailing products. Moreover, they have made a large number of ditches and ponds, which are posing health issues for the people of the area, and not even fit for fisheries and plantations~~.~~ https://www.Odisha-minerals.gov.in/LicenseeStatistics/CircleWiseLicenseeDetails

The Joda /Barbil area has the fifth largest deposit of iron in the world, besides manganese and c~~C~~hrome ore as minor source. The ores are the major revenue generation source for the state and central Government. There are eighty Industries are mining allied (North Orissa Chamber of Commerce & Industry data) generating revenue for Odisha **(Fig 3).**

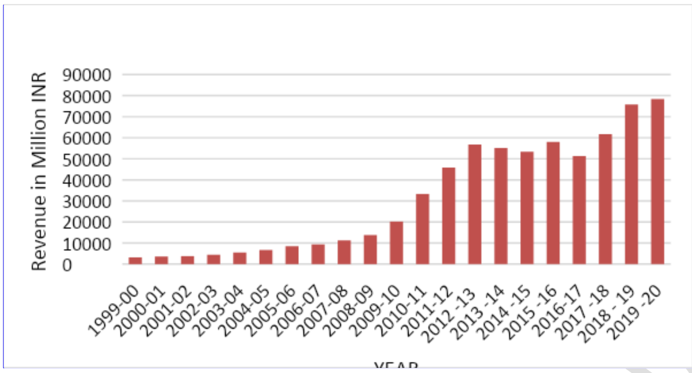

Fig 3: Revenue generation from mining sector in Odisha from 1999-2000 to 2018-2019. (source: www.Odishaminerals.gov.in).

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~~This~~ Barbil town has manufacturing units like steel, Iron ore pellets, and liquid oxygen. The area is laden with dust due to mining, industrial operations and plying of mineral loaded trucks (about 7000 dumpers) in the night through the town as no bypass roads for heavy vehicles around Barbil. The dolomite mining area housed in the Saranda Hill slopes in the EGB hills in the mountainous reaches of upper Baitarani Basin with the polluted drainage channels Suna, a sub tributary of Baitarani River and south Karo (Koel Sub-Basin) (Panda et al., 2020[3]).

Review of literature:

Revenue sector through mining sector in Odisha is ever increasing and simultaneously deteriorating the environment and socio ecological systems (Malaviya et al, 2010[4], Panda et al, 2014[5], Haddaway et al., 2019[6]); Mining areas acutely pollute water, air and soil causing mainly respiratory diseases, mal nutrition, vegetation loss, and ecosystem degradation (Hota et al., 2015[7]). Mines are susceptible to accidents, metalliferous dust and toxins exposure, fatigue and stress from the work settings, or managerial anxiety builds up that affect not only to miners but also to his family and friends (Entwistle, et a;., 2019[8], Stewart, 2020[9]). The long-term targets of the Paris Agreement-2015 warrants prompt cessation to deforestation, encourage reforestation/afforestation at large scale particularly in industrial areas with waste dumps, water accumulation ponds, and processing structures, (Zobrist et al., 2009[10]; Maus et al., 2020[11]).

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Mining accomplishments change their the topography of the natural resources of the mining areas, Land use / Land cover (LU/LC), environmental concerns, anastomosis of drains, soil losses, vegetation loss, waste generation, and ground water pollution. (Mathew et al, 2016[12];, Mana et al., 2016[13] and 2018[14]; Garai et al., 2018[15], Panda et al., 2020[3]). Comparison of statistics of GIS study results the planners and managers can make strategic plan for the deteriorating over exploited mining areas (Khan et al., 2018[16]; Chang et al., 2021[17]; Punimia et al., 2021[18]).

Objectives

- To investigate topographic constraints (Slope, drains, watershed)
- To investigate of Land use (LU) and Land cover (LC) changes (2003, 2009, and 2014)
- To examine climatic change impacts (SAT, NDVI, precipitation etc., (2007, & and 2018)

Present search will help to prepare records for the forest cover and plan for the degraded forests associated with mining disposals. Restoring energy, agriculture, and water bodies' can have safe mining activities and encourage vegetation in quarries, waste dump areas.

Topography

The study are belongs to Singhbhum carton of granite formation, and in Baitarani upland (200 to 400m above MSL) with Similipal plateau, and Keonjhar plateau. Keonjhar plateau contains bauxite duricrust and Similipal plateau covers Laterite formations. Joda and Barbil lies in Similipal plateau. The Similipal plateau has 600m to 800m uplands of 600m to 800m whereas 300 to 400m low flat terrain at 300 to 400m above MSL sloping from north to south. https://ibm.gov.in/writeread data/files/07272015155420ORI-19.pdf

Stratigraphy

A Banded Iron Formation of volcanic sedimentary rock masses are encompassing the Singhbhum Granite lying in the northwestern exposure between Barsuan – Noamundi as folded into a Horseshoe synclinorium spread over area 60Km X 25Km containing minerals mainly iron, chromium, and manganese. The study area comprises of Singhbhum Granite Batholithic Complex lying as north-south elongated tract about 8000Km^2 made up of alternate 12 magmatic bodies of biotite-granodiorite-granite emplaced in three distinct but closely related phases of Similipal group, and three other smaller granitic intrusion (Sengupta et al., 1997[19]; De et al, 2021[20]). Hematite is the chief mineral of Barbil area. The important active mines areas are housed in Thakurani, Joda east, Bolani, Sidhmath, Khandbhanda,

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Kasia-Barapada, Belkundi, Bolani, Gurudia, Kiribura, Dubuna, Jharibahal, Murga, Bamebari, Palsa, Jajang, Guali, and Uliburu. Iron ore bands are tough massive (64-68% Fe), laminated (62-65% Fe), lateritic (65-68% Fe), and Powered blue dust (MoEF&CC-2018[21],DSR Keonjhar-2018[1]). The contour, aspect and slope map of the area is in **fig 4 (a to c)** as on 02-02-2021.

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The land sat data collected was from 02.02.2021 without cloud. The imageries from LC08_L1TP_140045_20210202_20210306_01_T1 with data from Band source data of Cell Size (X, Y) - 30, 30, with Spatial Reference -???

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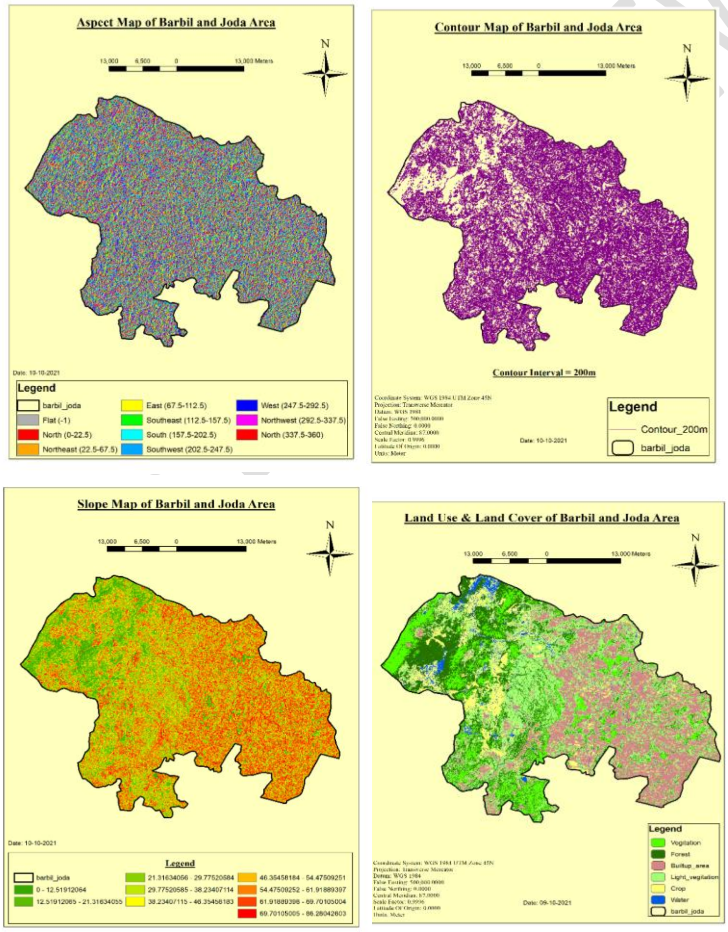

Fig 4(a-d)—: The aspect and the contour Map Joad and Barbil areas in Keonjhar Odisha.

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???WGS_1984_UTM_Zone_45N used for aspect contour and the shape map where in Landsat-8 considered. For Land use and land cover the steps followed are Landsat 8 collection 1 level 2

data collected from USGS earth explorer, Composite map was in produce from bands 1-7. Shape file of the study area was under insertion and the after masking out the required area.

By using the image classification tool, the features of the area distinguished, and sampled by the training sample manager. After sampling, the similar samples were categorized and assigned names and colours. Later by help of the tool - Most Likelihood Classification, the groups were under analysis and the land use and land cover map to obtain the LU/LC map.

Soil of the area: The study area covers mainly laterite and lateritic soils are compact to vesicular, and at places honeycombed, composed mainly of a mixture of oxides of iron and aluminum. These soils are less fertile as permeable, acidic and are poor in nitrogen, phosphorus, potassium and calcium.

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Climate: Mining activity has made the area very hot summer, cold winter, and dusty atmosphere. The ~~area experiences~~area e x p e r i e n c e s northwesterly thunderstorm activities with a high lightening prone area. ~~The undulated~~The undulated roads with large potholes, with continuous mining activities have made the climate unhealthy, suffocating and make the dwellers fatigue soon (Imran et al., 2021[22,])

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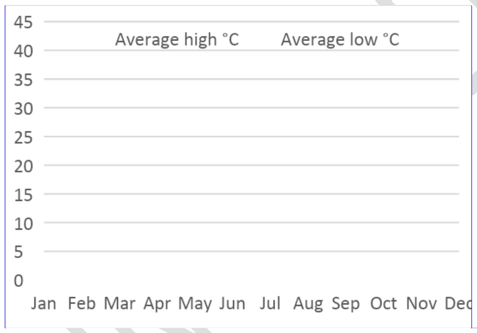

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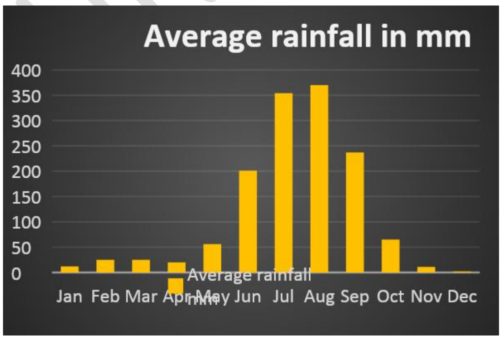

Fig 5: Mean monthly temperature & Average r/f of Barbil the year (GOO Masterplan -2030)

The mean monthly temperature of the study with high and low temperatures are 30.77°C and 19.29 °C respectively**.** The average annual rainfall is about 1378mm (**Fig 5 (a) & (b)**,

Flora and Fauna: The gorgeous flora & fauna adorns the mines area and houses wild elephants, Tigers, sambhar, etc. adjoining forest areas. The area is ironic in forest resources with large forest areas such as Thakurani, Ulliburu, and Saranda Reserve Forests. They are dense forest and hilly region (Behera et al., 2015[24]),

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Methods and Methodology

The present study involves the mining area changes, management of Barbil Tehsil area using Geospatial detection method for strategic planning to protect forest vegetation, existing agriculture set up from further deterioration in the mines area. The methodologies applied are collection of images and data from the USGS websites (open source) like SRTM and CARTO DEM (30 m spatial resolution). The images are georeferenced and further used for terrain, and drainage pattern analysis using slope, elevation etc. of the area. The geographical features like contour and datum further abstracted for the analysis.

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Satellite imageries and data (LISS III and LISS IV) is in use for the intended mining area management, and change detection through various imageries (multi spectral) collected from NRSC "Bhuban" website and NIRD & PR lab. Image classification for the LULC at 6 years interval on LISS data is the focus of the study. Landsat 8 TIRS (Thermal Infrared) and, Landsat 5 TM (Thematic Mapper). These data, collected from the USGS websites are of use in Normalized Difference Vegetation Index (NDVI) and Land Surface Temperature (LST).

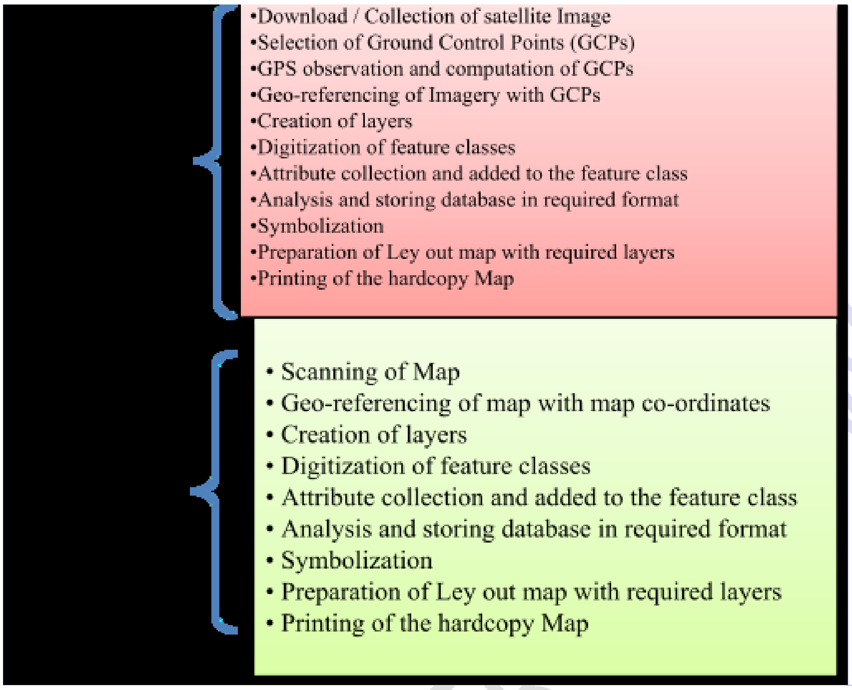

Fig 6: The map from the satellite imagery & the hard copy map to feature class:

The GIS method is opted for comparison of the environmental losses that has occurred due to mining activities in Joda and Barbil area. The various steps involved are getting the map from the satellite imagery and the hard copy map to feature class:

Sat-Data Used

Present study uses Landsat 5, 8 and CARTOSAT DEM data of acquisition on various temporal and spatial resolutions various satellite imageries used in the study and LISS data, collected from NRSC Bhuban website and NIRD & PR lab (**Tab 1**).

Table 1: The inheritance of satellite data and spatial resolution of the study area

Sl.No.	Resolution (Spatial)	Sat- Data used	Acquisition date
I	30.00m	CARTO DEM	23-1-2016
II	23.00m	LISS III	10- 05- 2016
III	5.80m	LISS IV	February 2003, June 2009
IV	30.00m	Landsat 5	22 – 01 -2007
V	30.00m	Landsat 8	15 – 12 -2018

SOFT WARE USED

Software are used in the study are **Arc GIS 10.1** (GIS software of ESRI, USA), is a platform for designing managing, solution to create by using geographical maps, geographic data

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compile, and analyze mapped information using boundary as shape file, classification to find Isohyet and Isopleth maps. **ERDAS Imagine 9.2 (**remote sensing (RS) application software) is image-processing software.

Land use and land cover (LULC) changes

Hasty vicissitudes in the LULC of an area have turn out to be a major environmental distress in recent times (Imran et al., 2021[22], Li X., 2021[25]). This has commanded untenable development with the drop of green corridor along with variations in local climate and creation of urban heat islands (UHI's) (Guha et al., 2017[26]). Land use are in use for the analysis of environmental processes and problems. In present study for LULC classification, LISS data are in use .The multiple year of LISS data are in use for LULC classification, like LISS III, IV (2003, 2009, and 2014).These multispectral data submit for supervised classification using ERDAS 2014 Image Processing software (Kayet et al, 2016[27]).

Supervised Classification

The collected RS data was geo-referenced and properly clipped assigning to the study area. The LULC classification made by ERDAS 2014 image processing software by supervised classification techniques. The supervised classification involves development of spectral signatures in some definite location or training sites in the imagery. The vector layer related to different polygons overlaying for various LU types digitized over the raster section. The training locations help ERDAS to grow spectral signatures for the outlined locations. The classification of images executed with the (MLA), Maximum Likelihood algorithms. Presently the land use categories are water body, agriculture land, grassland, built up land, mining area and forest.

Land Use and Land cover

Maximum Likelihood classifier is a supervised classification technique. When classifying an unknown pixel, that evaluates both variance and covariance of the spectral response pattern.

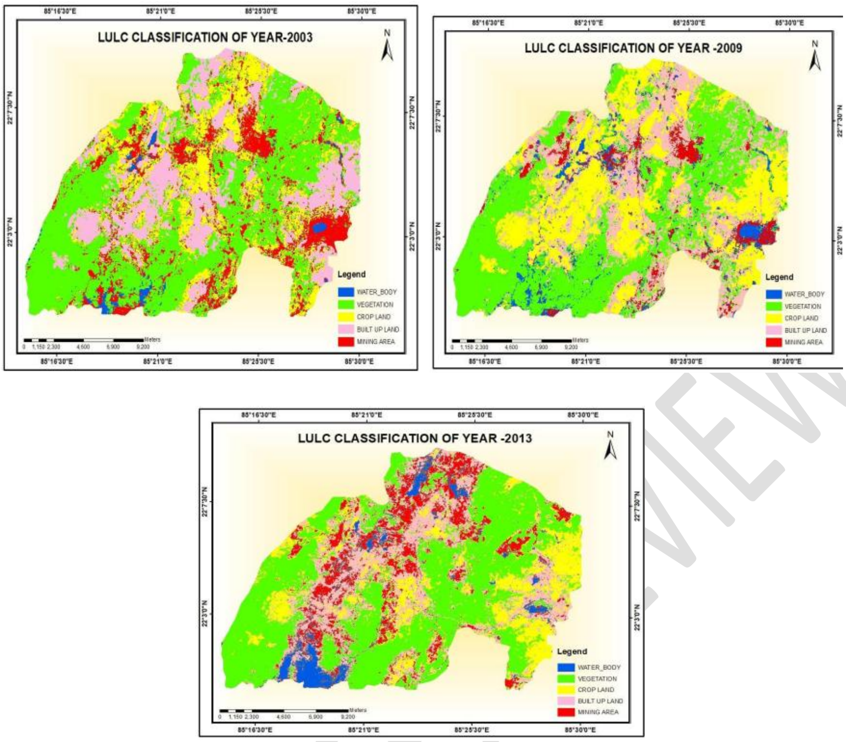

Fig: 7. LULC classification of LISS IV in the year 2003, 2009 and for 2013 (LISS III data)

The LULC under **Table 3 & Fig 7** shows the vegetation cover decline (including the open, dense forest and shrubs) area from 141.51 km^2 to 110.45Km^2 within the year 2003 to 2013.

Table 2: Class statistics of each land use class from 2003 to 2013 of single watershed area.

Class	Area in square meter		
	2003	2009	2013
Vegetation	141507054	132955943	110446690
Crop land	60236030	53440760	46612965
Built up land	57035927	72313523	84567395
Mining area	44707156	46063650	59803042
Waterbody	14705880	13415353	16800557

This might have caused due to increase in mining area or may built up land. In **Fig 4** show classified land use and Land cover were shown using MLC techniques. All the changes take place, which are in below **Fig-8**.

Accuracy assessment

The amount of accuracy depending upon the data quality is the grade of nearness of results to the ground trothing values i.e. accepted and approach the real world. The accuracy of the assessment model was to find the extent how many ground truth pixel are correctly classified. The procedure of precision valuation in thematic maps can improve land use and land cover classification by permitting unambiguous response of heterogeneity units and scale in the map.

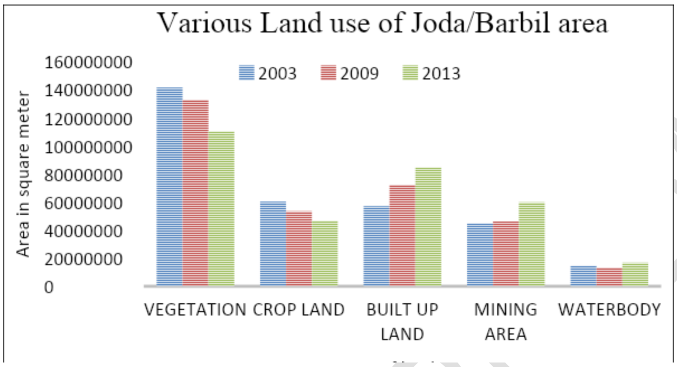

Fig 8: The various land use and land cover in Joda/Barbil areas 2003, 2009 and 2013

Consistency of the supervised classification was for validating the results from the results of accuracy assessment performance on the LU/LC map. Valuation results obtained from the stratified random sampling method of classified image from the year 2003 showed a total accuracy of 93.55 with a kappa coefficient of 0.9031. The same for 2009 and 2013 of the classified images were 94 % and 88.75% with kappa coefficient of 0.9103, and 0.8392. The producer's accuracy, user's accuracy and Kappa coefficient for different classes (**Table 3).**

Table 3: Comparison of accuracy assessment results of LULC maps

Year	2003		2009		2013	
Class	Prod. Acc.	User Acc.	Prod. Acc.	User Acc.	Prod. Acc.	User Acc.
Water body	100	100	90	85.02	0	0
Built up area	100	62.02	100	100	100	90
Crop land	100	100	100	92.67	100	77.78
Mining area	92.86	92.86	91.67	91.67	100	75
Vegetation	100	88.05	0	0	100	90
Overall accuracy	93.55%		94%		88.75%	
Kappa Coeff.	0.9031		0.9103		0.8392	

Surface Air Temperature (SAT)

The surge in demography has demanded human settlements, rise in mining and industrial activities. The exploded urban areas due to rural migration has influenced, the surface air temperature (SAT), and upper air temperature (Connors *et al*., 2013[28], Guha et al., 2020[29], Faisal et al. 2021[30], Nagassa et al., 2021[31]). The township has turned up as urban heat island (UHI's) which refers to the relative warmth of urban surfaces, and urban atmosphere. The players for the UHI's include climate change, weather adversities, topography, and chaos in city life. The anthropogenic activities, especially in urban development, have transformed the natural landscape cover to built-up areas. The vicissitudes can have substantial consequences on native meteorological parameters (Choudhury et al., 2019[32], Abulibdeh, A., 2021[33]).

Satellites employed to gather information about various surficial changes like LU/LC and SAT. Landsat-8 can identify the contribution of urban settlements, UHI's and the significances of land use change in the forest areas. Landsat-8 has two bands 10 and 11 that uses for evaluating the SAT: influence through CO2 in 11 band (Nagassa et al., 2020[31]).

Surface air temperature (SAT)

Present study have used the Landsat-5, 2007 and the Landsat-8 of 2018 and satellite data. Images of thermal bands (band 10) for year 2018, the band 6 (thermal band) in year 2007 was analyzed to identify the surface air temperature. In Landsat 8, band 11 shows less temperature when compared with band 10, because band 11, being closer to powerful 15µm band of CO2 that influences atmosphere than band 10. Ground trothing of SAT data of meteorological stations tallied to assess the real-time variation. The calculation of SAT involves the following steps: (Rajeshwari et. al., 2014[34]).

Step (I):- The convertion from digital number (DN) to Top of Atmosphere (TOA) radiance (upper air)

$$L_\lambda = M L\, Q cal + A L$$ ---Eq. (1)

Where; L_λ = TOA Spectrum radiance; M L= Band specific multiplicative rescaling factor; AL = Band specific additive rescaling factor; Q calories = Quantized, and calibrated standard product pixel values

Step (II):- To convert TOA values to TOA Brightness Temperature in Kelvin T

$$T = K2 \ln ln (k1 \quad K\lambda + 1)$$ ---- -- Eq. (2)

Where; T= TOA (upper air) brightness temperature; L_λ = TOA (upper air) spectral radiance; K_1= thermal change constant (Band specific); K_2 = Band specific thermal change constant

Step: - (III) To convert Kelvin to Degree Celsius

$$T^0\ Celcius = T^0\ K - 273 \text{ --------------------------------Eq. (3)}$$

The values obtained from bands 10 and 11 were collected from Meta data. K_1 & K_2, rescaling factor were derived using above equations (1 & 2) (Rajeshwari et al., 2014)[34]

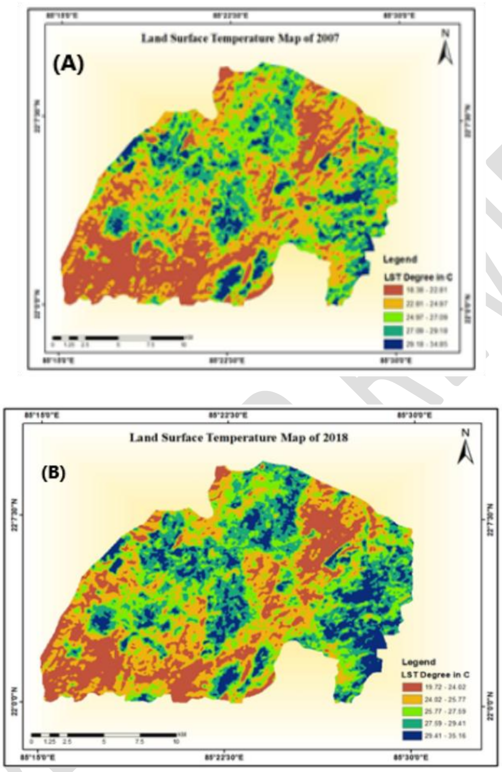

Figure. 9 (A): Surface Air temperature Map for the Year 2007; Fig. 5 (B): Land surface temperature Map for the Year 2018

In the year 2007, the minimum Temperature 18.38 0C, maximum Temperature 34.85 0C), and during 2018 the minimum temperature 19.72 0C, and maximum Temperature 35.16 0C. The temperature of sturdy area are estimated by using the wavelength of 6th band ranging from 10.4 to 12.50µm (micrometer) of the electromagnetic spectrum. The wavelength of band 10 ranges from 10.60-11.19µm, and value for 11th band ranges from 11.50-12.51µm **(Fig 5(A) & 5(b).**

Table 4 : Changes in temperature in different classes of LULC (during 2007 and 2018)

Land cover	year	
	2007	2018
Class	Band 6	Band 10

Water body	19^{o}C	22 ^{o}C

Vegetation	20 °C	22 °C
Crop land	23 °C	25 °C
Built up land	27°C	28 °C
Mining area	32°C	34 °C

The SAT is well distributed (Fig 5A & Fig 5B), and the minimum 18.38°C, and maximum 34.85°C temperature was recorded for the Barbil mining area in the year 2007 and of 19.72°C (minimum), and maximum temperature of 35.16 °C in the year 2017 is observed (**Table 4).**

Normalized Difference Vegetation Index

Normalized Difference Vegetation Index, the NDVI compute greenly vegetation by determining the changes between near infrared (that reflects vegetation strongly) and red light (that vegetation absorbs). NDVI always ranges from - 1 to +1. NDVI used to estimate crop yields, pasture performance, *etc.* Luxuriant flora absorbs a lion's share of the spectra of visible light that is incident on it, and reflects a major part of the near infrared light. Unhealthy or sparse vegetation reflects light that is more visible and less near infrared light. The NDVI statistics utilizes by concentrating on the bands of the satellites, those are sensitive to vegetation data (near infrared and red). The bigger the difference point to higher vegetation.

Estimation of NDVI

Present study, uses Landsat images of different years 2007 and 2018 for NDVI estimation. Classification for the change in forest cover, mining area, cropland and watershed ranging for a period of 11 years. The variations were examined by using three types of datasets separately and generated maps for the five classes i.e., lacustrine areas, built up land, mining area, vegetation and cropland. There had been dense forests during 2003, but the forest cover became sparse in the years 2007, and 2018, which has been under consideration for comparison **Fig 6 (A), and Fig 6B**.

.The NDVI using the visible and near infrared region can reflect the greenness, and the amount and thickness of vegetation can be obtained. Greenly vegetation absorbs major share of the visible light that hits and reflects a large portion of the NIR. Poor and sparse vegetation reflects more visible but less NIR light.

$$NDVI = \frac{NIR-RED}{NIR+RED} \text{--Eq. (4.4)}$$

Where: NIR =Reflectance in near infrared Band, and RED=Reflectance in Red Band

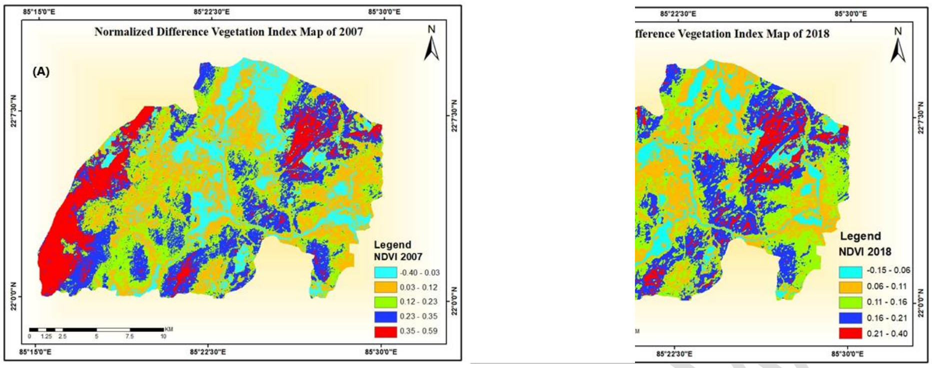

Fig 10 (A) and (B): Comparison of NDVI of Barbil area in year 2007(A) and 2018 (B)

In the present study, Fig. 5 and Fig 6 clearly infers the NDVI variation over the Barbil watershed. The NDVI values varying between - 1 to + 1 has been segregated as - 1 to 0 (water bodies), 0.2 to 0.4(sparse open forest), and 0.4 to 0.8 (scrubs, and light vegetation), and built up area 0.8 to1 as dense vegetation. The pixels considered in the NDVI images of all class are in **(Table 5).**

Table 5: NDVI values considered for various classes NDVI indices.

Classes	NDVI Values (-1 to +1)
Water Bodies	-1 to 0.06
Built up & light vegetation	0.06 to 0.13
Mining Area	0.16 to 0.3
Heavy vegetation	0.3 to 0.4

NDVI are helpful to differentiate the Land use and Land cover type in the area of study in order to study the co-relation with Land surface temperature variation in the selected lacustrine area. The loss of vegetation is because of increase in mining activity and increase in built up area.

Co-relation between SAT and NDVI

In the **fig 5 & Fig 6**, clearly shows a strongly -ve correlation between SAT and NDVI within the Watershed. The SAT and greenly vegetation depends on the variations of rainfall in the rainy season of the year and the +ve correlation between NDVI and SAT found in the warm months from May to October (Sun and Means, 2007). The correlation between SAT and

NDVI indicate that Barbil has turned out as drought prone area due to reduction in forest cover.

Discussion:

Odisha state shares from the country’s production of some minerals are Iolite, and Chromite 100%, 70.95% of Bauxite, 59.64% of Iron Ore, and 39.28% of Graphite, Manganese Ore of 18.51%, and Limestone of (1.57%) as per Annual report of Ministry mines, Government of India 2020-2021.

The sectors that mining area lagging are illegal mining which collapse the mining regulation stipulations. The Consequences are due to deficiency in Governance, failing to track basic norms and agreement with the indicators. The tendering procedure, evaluation, identification of mining volume, production figures, and clashes of interest, and accusations of corruption are the focusing factors in the mines management in the area.

Before leasing the mines, it is essential to have the environment impact assessment considering the human right and aboriginal tribes health, ecology and livelihood concerns. The portable water, ground water, irrigation and water supply to the mines area needs attention. The usual threats, violence, protests, responses, inevitable scandals in the area needs responsive action and management.

Last two to three decades there is collapse in mining sector management. There is poor operational strategies in mines, which has age-old criticisms, and complaints against corruption, lack of accountability for losses in wastes, environmental degradation, waterlogging in open cast mine pits, regular seizures, and human rights violations. It is essential to frame regulations, regular seizes, GIS application to assess volume of excavations, to have strict vigilance of existing mines, and afforestation, reforestation of degraded/lost forests in Barbil area.

The mines and minerals (development, and regulation) amendment act (1957) have superseded by the Mines and Minerals (Development and Regulation) Amendment Act, 2021 in India for judicious management of the mines and its associated natural resources. The Act can regulates the mining sector as:

a) Removal of imposition on end-use minerals,

b) Use/ reuse of minerals by captive mine,
c) Auction of mineral concessions (except coal & atomic minerals) as per Govt. norms.
d) Rights of certain existing concession holders,
e) Allocation of mines with expired leases,
f) Extension of leases to government companies,
g) Conditions for lapse of mining lease, and
h) Non-exclusive reconnaissance permit.

Strict implementation of the act, the mining areas can reduce/reuse wastes, stagnant ponds, and save the environment, https://prsindia.org/billtrack/the-mines-and-minerals-development-and-regulation-amen dment-bill-2021, (MoL&J-2021[35]).

Conclusion

The mines area management of land, forests and water resource (Surface and underground) is a growing concern worldwide. The impacts of over exploitation, illegal mining, mines area land management, trailing deposit put grave concerns and is inviting climate variation, deteriorating water quality, and quantity has developed a number of simulation models. Improving infrastructure facilities like afforestation/reforestation, water quality improvement, reuse of trailing, and saving the agriculture are the prime concern for effective mines area management.

From GIS studies for LULC of Barbil area, it is inferred that the due to excessive lease, illegal mining, and population surge there constant increase in mine area and built up areas in and around Barbil Tehsil at the cost of forests and agricultural land since 2003 onwards. The SAT and NDVI studies shows that there is average temperature rise in the area due mining activities and infrastructural development. Before leasing a mine, it is imperative to have EIA studies, provisions for non-violation of the human rights and aboriginal tribe's safety, health, ecology and livelihood concerns. The portable water, ground water, irrigation and water supply to the mines area needs attention along with strict implementation of the Mines and Minerals (Development and Regulation) Amendment Act, 2021

COMPETING INTERESTS DISCLAIMER:

Authors have declared that no competing interests exist. The products used for this research are commonly and predominantly use products in our area of research and country. There is absolutely no conflict of interest between the authors and producers of the products because

we do not intend to use these products as an avenue for any litigation but for the advancement of knowledge. Also, the research was not funded by the producing company rather it was funded by personal efforts of the authors.

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