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IMPACT OF MINING ACTIVITIES ON GEOMORPHOLOGICAL DEGRADATION: CASE STUDY ON JHARIA COALFIELD AREA

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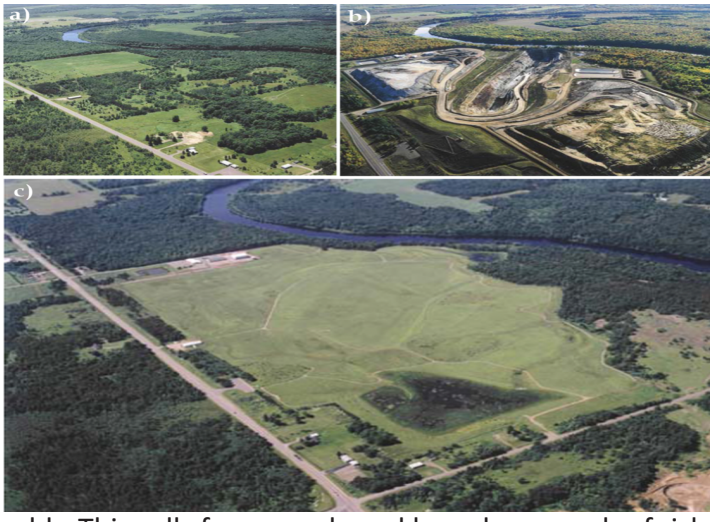
ABSTRACT



The fundamental problem to be addressed here is the use of coal without adversely affecting the environment, which requires development of new technologies or modification of the existing, but above all a research oriented planning with proper technological aid. The traditional approach of mining and control on its impact to the environment has reached its limit of effectiveness. Mining in India is primarily labor intensive, which is why any of the small effect is hard felt. On the other hand it is one of the necessary evils of the modern world. This calls for a new broad based approach of risk assessment and safety management plan with judicious blend of existing system for a proper environmental impact assessment. Among the present technological advancements implementation of remote sensing and GIS technology sounds the most relevant and its best implementation is what is desirable. Some of the most recent geographic tech tools that need an eye from the Indian mines utility perspective. Documenting recent status on regular basis with high resolution imageries for ecosystem and biodiversity issue along with the economic documentation in all direction would be the best way to support planning process with immediate implications unlike long term wait for results.

This paper involves the spatial pattern of interactions between physical environment and human activities and the remedial measures of adverse responses emanating from such.

KEYWORDS : *coal mining, remote sensing and geoinformatics, sustainable development, environmental degradation.....*

INTRODUCTION :

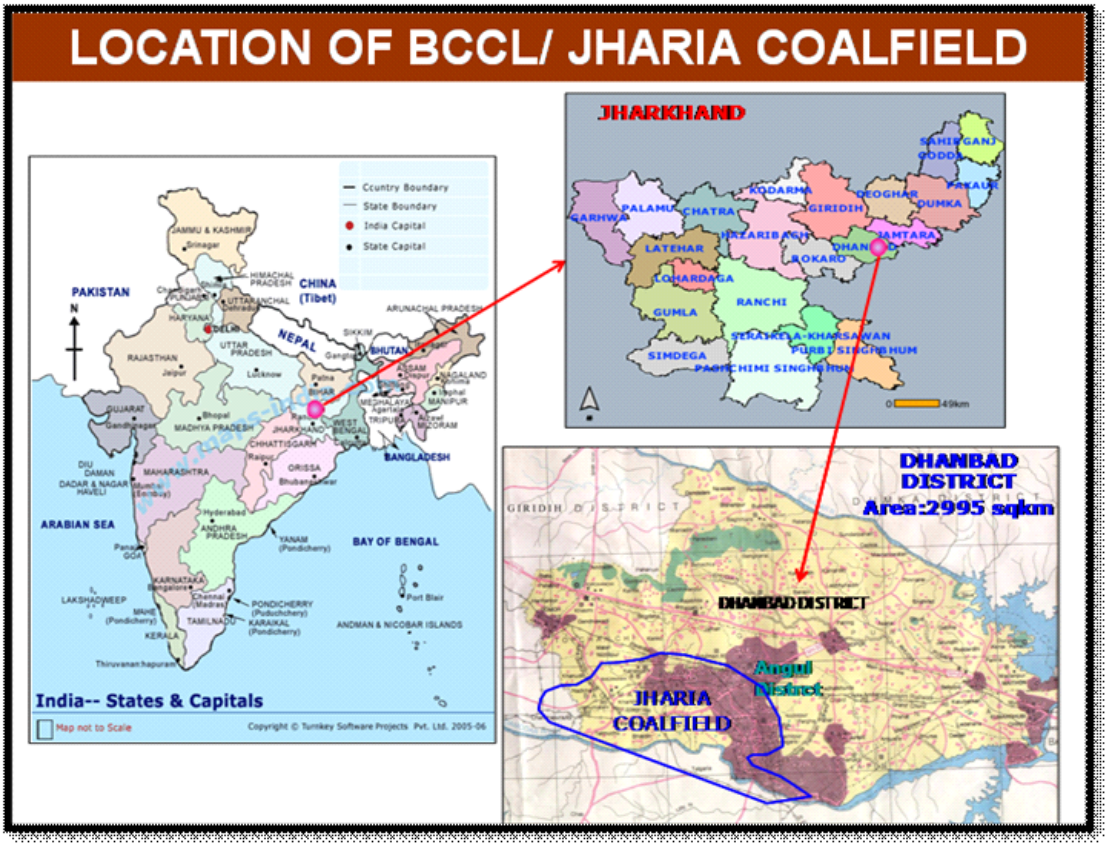
Land use conditions are bound to change in any area where even some amount of mining activity is going on every day. The fundamental problem to be addressed here is the use of coal

without adversely effecting the environment and the main focus of which will be Jharia coal field which gains its priority status from the fact that it is the exclusive store house of the prime coking coal in the country.

Relative to other fossil fuels, coal is less energy efficient and pollutes more. So the challenge is to apply the right technology in the most efficient and environmentally friendly way. The present work is an attempt to prepare overview of impacts inflicted upon the landscape and a self established suggestive measure to minimize its effect on population dwelling in. To achieve this remote sensing data has been used as basic tool of study.

STUDY AREA – JHARIA COALFIELD:

Jharia coalfield is located in the Dhanbad and Bokaro district of Jharkhand state, at a distance of 260 km from Kolkata. It is bounded by latitude of 23°37' to 23°49'N and longitude of 86°08' to 86°30'E encompassing a total area of about 450sq.km. Jharia coalfield was a highly attractive area mainly because it has one of the highest concentrations of thick coal seams in the world and has been subjected to exploitation for more than 100s of years.



LOCATION MAP OF STUDY AREA

IMAGE 1

Material and method used:

Topographical map: thestudy area is covered by Survey of India Toposheets, numbered 73I/1, 73I/2, 73I/5, 73I/6, in 1:50,000 scale. Satellite imageries were downloaded using Google earth at a time interval and software used to process it is Arc GIS. With this a small field survey was done to get the original view of the present state of Sendra Colliery where open cast mining is undergoing, which is

considered to implicate much of effect to the original landscape.

TOPOSHEET 73I/5, 73I/6, in 1:50,000 scale
IMAGE 2

Geomorphology of Jharia coalfield:

Mining an important activity is responsible for environmental degradation and the first stroke to it is felt by its geomorphic status. Jharia coalfield is taken as one of the series of parallel basin of rifted valley. Its surroundings are characterized by gently undulating to a rolling topography with overall slope towards east-south-east. The topography bears physiographic units like hillocs, escarpments, pediplains, monadknocks, and valley side slope and valley flats. The elevation in the area ranges 240m in the west to 140m in the south east nears the Damodar River. The basin is more or less oval shaped with a well defined outline.

In Jharia coalfield, faults are dominated linear feature. The Gondwana sediments of Jharia basin is largely characterized by several fault systems and its frequency helps us know that the seams occurring in layer patterns a bowl shape which gives scope for further analytical adjustments here towards safety.

The study area is covered by Damodarriver and its tributaries like Barakar. The areas compised of coalfield areas and alluvial tracts. The main geomorphic feature and land form in this study area are alluvial plain and dissected pediplains. The alluvial plains are found near the river tracts and consists of gravels, sand silt clay etc. the dissected pediplains are developed over gondwana formations found in Jharia.

The recognition of geomorphic-environmental crisis:

Apart from the fact that intensely mined areas are largely tribal belts, they are also forest pockets. Deforestation in extensive scale is the consequence. Surface dumps of over burden from the underground mining have rendered the soil beneath useless and the absence of proper strategy for reclamation the area is reduced to wasteland over a period of time.

Coal mining activities in the Jharia coalfield started as early as 1890 but the systematic work started from early 60's by the directorate general of mine safety which very well state the harm already done to it. At present there are 398 mines in Jharia coalfield (out of which 214 are coking and 184 are non-coking coal mines) under B.C.C.L (Bharat Coking Coal Limited. Subsequently, these units have been recognized amalgamated into 84 working units.

Almost all the mining operations were confined to the outcrop region due to the availability of thick coal seams near the surface. Queries were neither backfilled nor given any other alternative treatment to avoid future consequences. Due to such "slaughter mining" in the past, the land of Jharia coalfield got severely degraded. A bird's view will prove the cruelty it actually endured as it is now left with old abandoned queries, soil dumps, subsided area, cracks and pit whole with smoke erupting like an inferno, mine fire, broken devastated households and abandoned settlements for stretches of land. Large tracts of agricultural lands were encroached by urbanization and converted to degraded land.

Out of 110km² of mining land under BCCL 63km² are under abandoned mines.

Soil in this area show low fertility status and it poses real difficulty to regain its plant supporting efficiency which further degrades its status, not only of the land there but also the pollutes the air and water.

Subsidence is almost an inevitable phenomenon in the underground mining depending upon several factors like the type of the strata and thickness of the seam.

Area under abandoned mines

1. Area under fire – 17km²
2. Area under external over dump – 6km²
3. Area under subsidence – 36km²
4. Area under abandoned queries – 4km²

Total area left unused - 63km²

Results of Unrelenting mining effect on the geomorphology of Jharia coalfield:

Jharia Reconstruction Scheme envisages to use of 203km² of land of coal mining operation. Out of this 203km² area of the land, 101km² is open cast mining and 102 is underground mining.

1. It has been estimated that after mining operation 99km² of land will be under subsidence and 63km² of land is already abandoned.

2.The fire underneath the surface due to coal mining led to extinction of number of rare animals, which is recorded in Jharia's history, thus destroying its biodiversity.

3.The erosion of the top soil/ subsoil during precipitation and wind/air effect above leaves bare rocks open rendering it useless.

4.The big pits or open queries form water bearing ponds leading to further unwanted consequences. Water logging remains un-noticed in major events and leads to underground mine accidents.

5.Development of cracks provid ventilation for mine fire contributing to its spread

6.Damage brought in to the infrastructural developments.

Most surprising fact is, inspite of all these dangers this place is experiencing more influx of

settlement which is making any small deterioration very hard felt. With the present population density of 2200 per sq km the available land is not enough. A closed mine of Bagdighi, numbered 12 is surviving a threat of subsidence that has 5000 families living in slum. This place is called the inferno on earth.

BURNING INFERNO ON EARTH
IMAGE 2

Geomorphological characterization of landforms using Geoprocessing data:

The power of GIS comes from the ability to relate different information in spatial context and to reach a conclusion about their relationship. The above stated negative impact of the excavation process leaves a long lasting mark on the geomorphological environment, particularly the quarries of Jharia coalfield have not been recovered and the possibility of compensating this depends on the knowledge of local geomorphology and the surface erosion. This geomorphological characterization can be best achieved by photogrammetric technique by using GIS to process Remotely Sensed data.

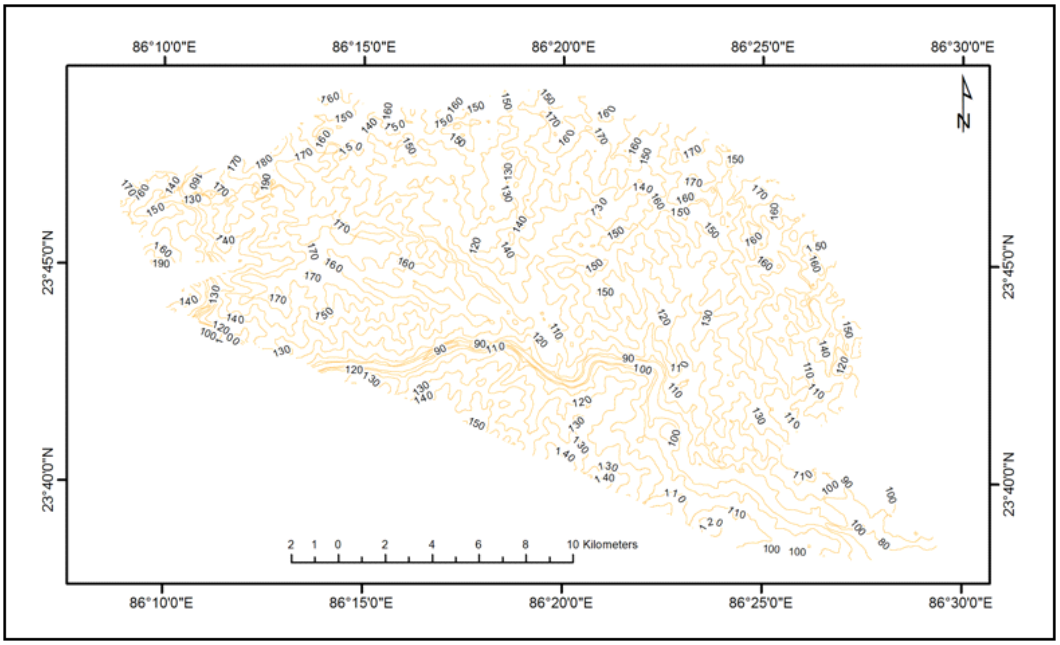
In this study a remotely sensed image of Jharia coalfield is downloaded from BHUVAN, obtained from National Remote Sensing Center.

Data used:

LISS III image of 20th October 2008 for the Jharia coal field area is used to show the geomorphological analysis. The DEM obtained was used for further analysis to dig out the detailed information of all type of features present in a geomorphological landscape which can further be used to the planning purpose.

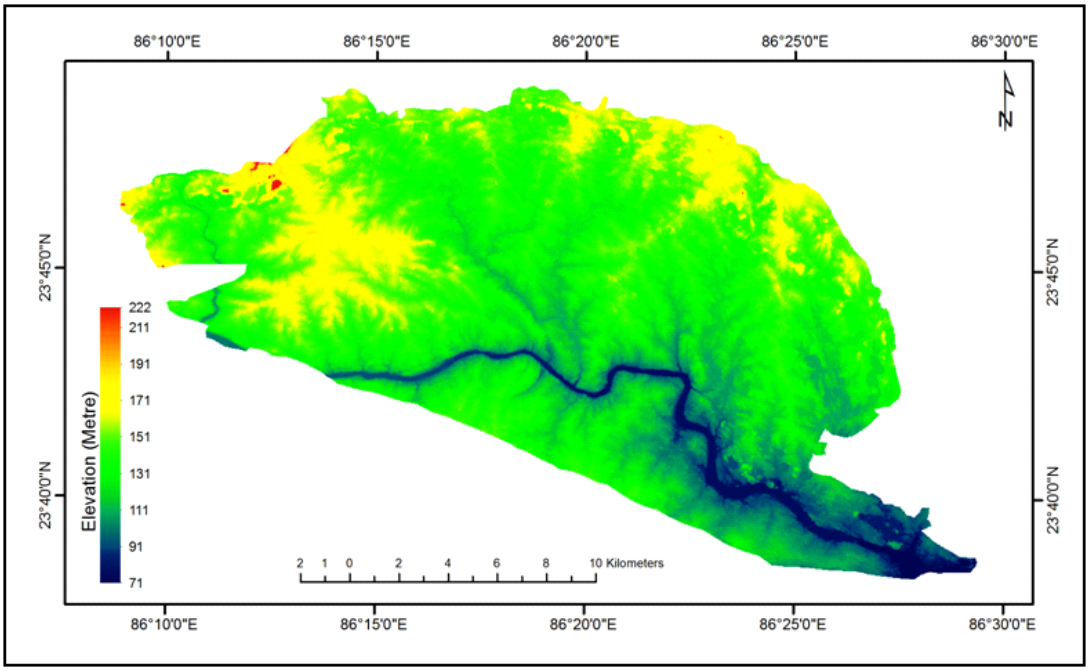
Processing flow of the coalfield analysis:

This includes the processing of the obtained DEM of Jharia coalfield from Bhuvan site, which is ISRO (INDIAN SPACE RESEARCH ORGANIZATION) geoportal towards the evaluation of the geo-morphologic status, the analysis of the region of interest, its terrain, slope, elevation etc which can further be used inGeomorphic designing principles offering the possibility of constructing valley fills in excavated open cast mines of the Jharia coalfield that have gently sloping contour arrangements.



CONTOUR MAP WITH 10 METER INTERVAL IMAGE 3

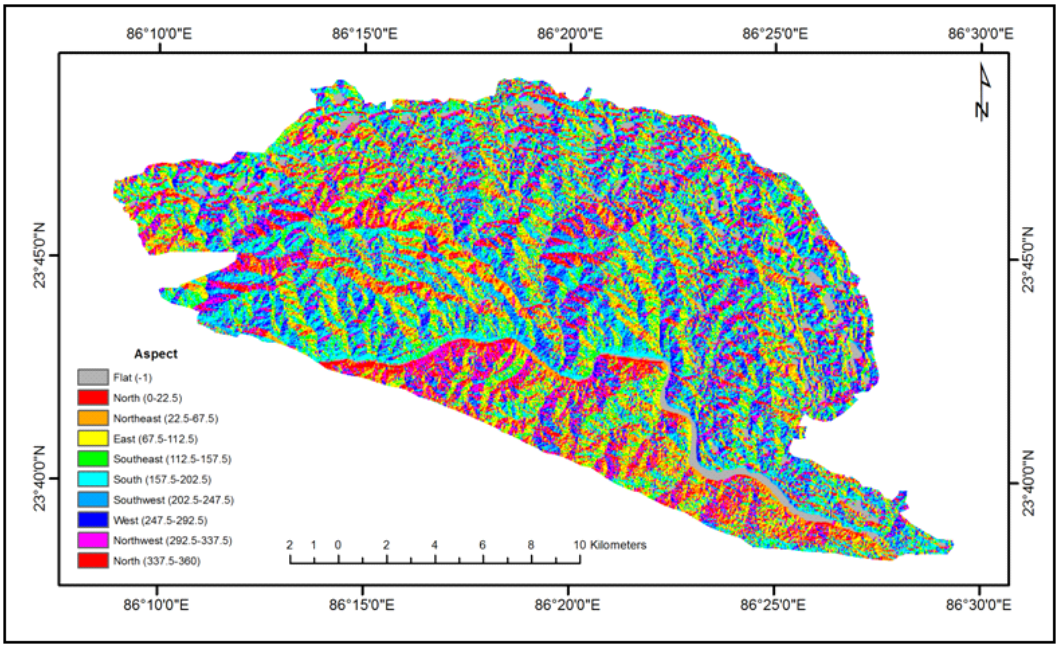
This contour map has been created from the DEM with 10m interval with the rang of not more than 80 m. the highest contour counts as 190 whereas the lowest is 80m of height above the mean sea level in the complete coalfield area of 450sqkm. This shows its gentle elevation which means even if it is left alone without any further disturbances and mining is completely stopped, it will take more than 100 years to level its quarries by itself unless there is again any major fault or fold occurrence.



ELEVATION IN METERS IMAGE 4

This elevation map has its range in meters, shows its uniformity as it's stated above in a better

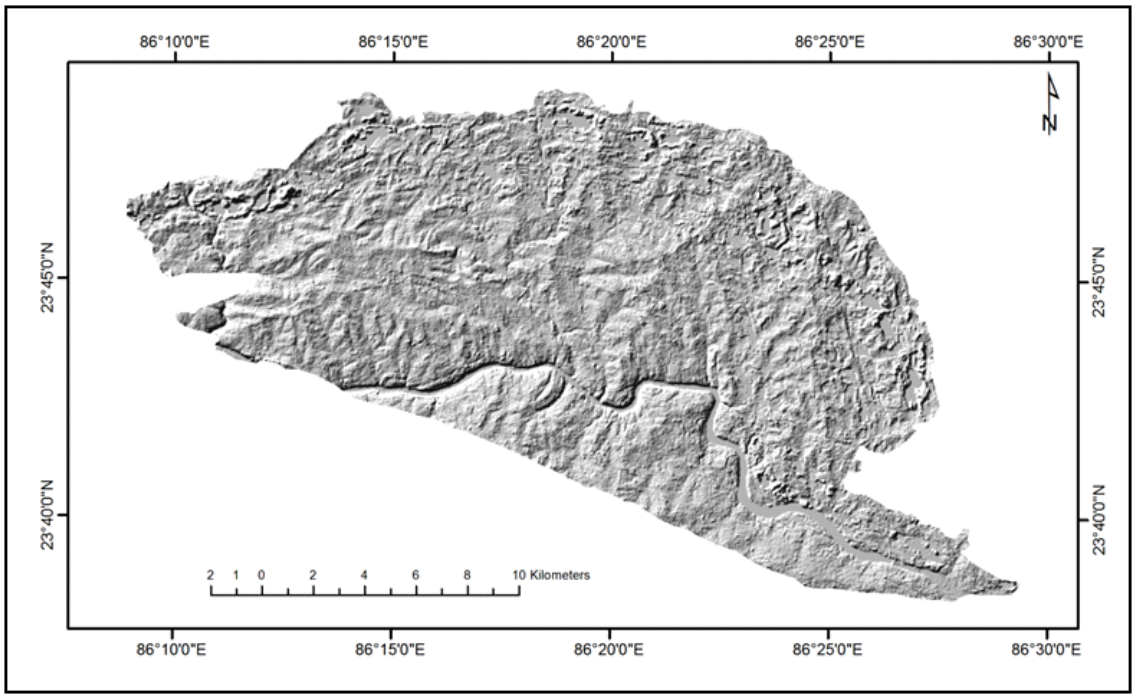
understanding level. It's just two to three spots in the complete area which has a noticeable high spot off more than 200 m else we see a uniform color throughout the area.



ASPECT RATIO

IMAGE 5

This image shows the aspect ratio where the height and width of the features can be compared with relation to its direction of slope. The red portion is showing north-ward direction which proves the direction of the flow of Damodarriver with a little east-ward attraction at the lower section of its flow. The smaller stream's direction can also be detected this way.

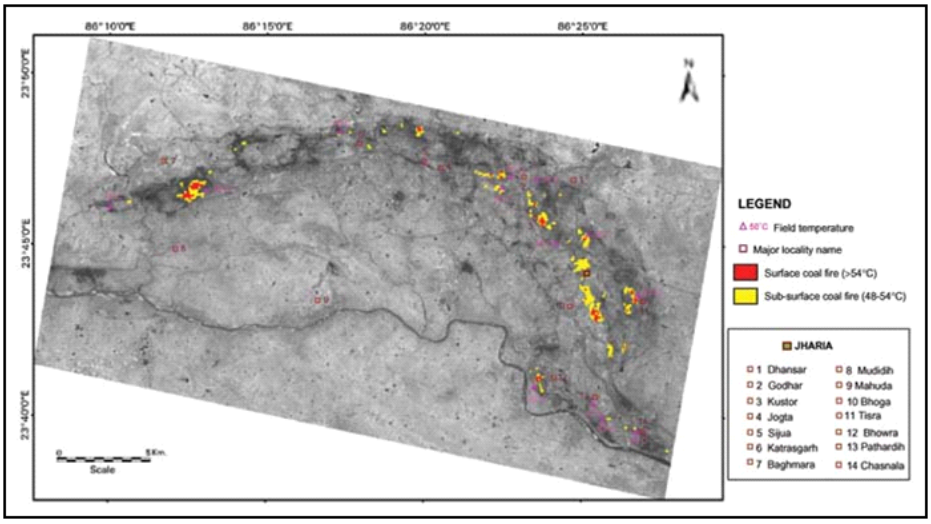


HILL SHADE ANALYSIS

IMAGE 6

This image depicts the hill-shade area of Jharia coalfield which proves this region to be a part of a plateau area. With a magnified observation we can see a deeper inundation on the northern section of the image which demarcates the ongoing open cast mining. From this it is possible even to evaluate the depth and thus related analysis can be made.

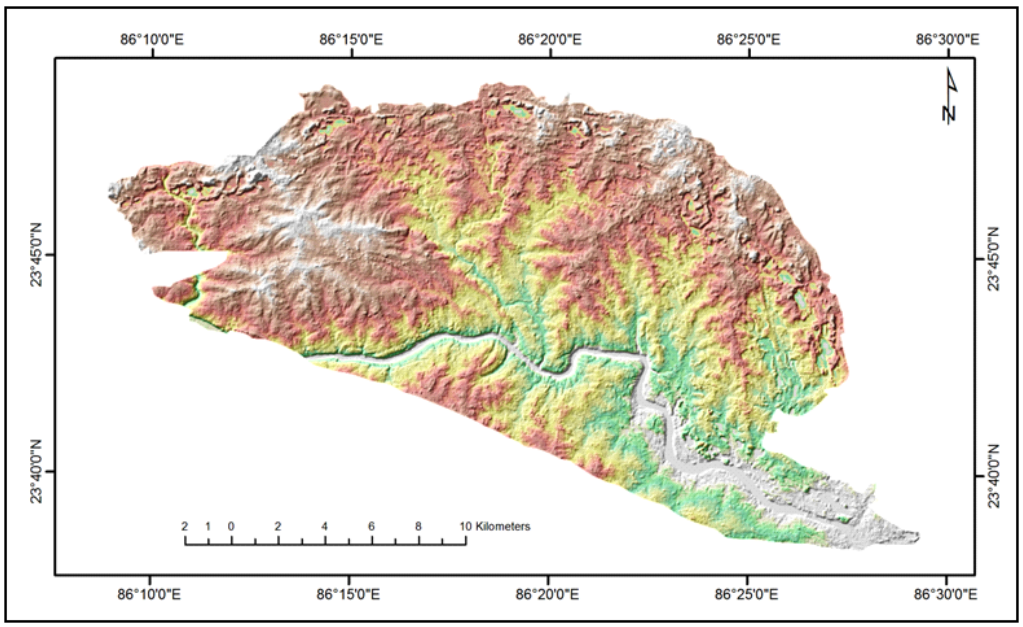
This also shows the availability of sun's rays over the varied terrain over the land proving a visual relief of the cartography.



EXISTING MINE FIRE 1

IMAGE 7

This image is of 2008 underground and surface fire status in the study area which gradually but quite steadily exhausting the resource and making mining a very hard endeavors here. It is not only uneconomic but also polluting the environment to an unthinkable extent. The land is left dead at the pointed locations.



PAINTED RELIEF 1

IMAGE 8

This image is the painted relief of the study area which just at a glance will give the observer a complete idea of the overall features present with a narrower idea of its elevation.

DERIVATIONS:

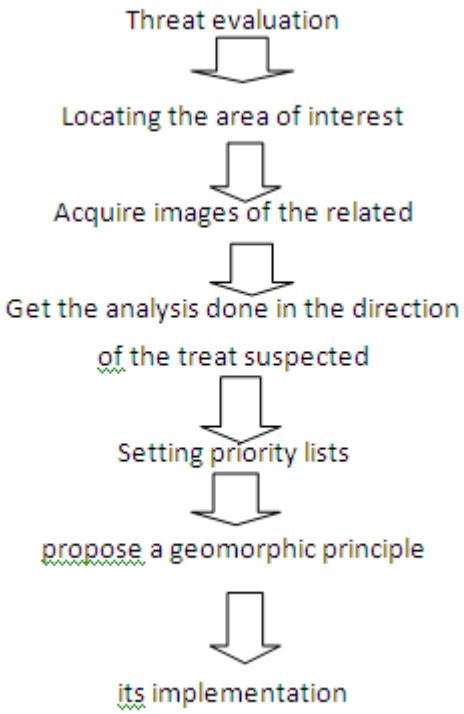
As we see from the images the north pat of the study area has more open cast mines than the lower and the middle portion so the area can be classified to implement different type of reclamation process and not classify all the land under the same. More over the fire zones can more confidently dealt with if we know the composition and the strata structure underneath. The hill-shade area will help to recognize spots where plantation will not be as challenging as the deal areas of the mines. The abandoned quarries that area filled with rain water are spotted from the images and then decided as to how it can be treated best economically as well as environmentally friendly manner.

PREDICTION-RECOGNITION-PREVENTION:

This is the ideal process to deal with the present state of mine to minimize the adverse effect of the mining if not completely discarded. REMOTE SENSING AND GIS process is the best suited for terrain evaluation and threat assessment in the study area.

The prior in-depth analysis with the help of these software in the direction of threat analysis will not only help in knowing the problem area but will also help in giving warning for the upcoming possibility.

WORKING SCHEME TO BE FOLLOWED:



Geomorphic designing is comparatively a new arena in the direction planning process in coal mining, especially in Jharia coalfield. Terrain analysis remains fundamental process in providing a predictive analytical proposition towards the health up gradation of the mine environment. The best fact about working with these advanced GIS tools is its capability of overlaying layers of observation for a comparative analytical conclusion.

PROPOSAL:

Sine these days the environment has became the major concern so this will help in detecting less energy consuming technologies that would in turn will produce less of heat and pollution, for example instead of using explosives for the excavation purposes if we can identify the strata structure and the weak point the faulting have induced in them then with an exact constant pressure coal can be extracted.

For the evacuation purpose in the study area, these images can be analyzed to see that only the outer rim is used as open cast mines. If we can estimate and super-impose the underground mines with threat of subsidence then we easily can recover the area where the evacuation expense need not be incurred or where the evacuation should be the prior concern.

CONCLUSION:

Coal mine reclamation should be best guided by the assessed original contour to that of the present to achieve slope stability and geomorphic health. This will help not only restore the previous harm done but will also help to follow a less harm inflicting mining process to lower the long term reclamation expenses.

Making models to see for the results in the computer is much more authentic, economic and feasible than implementing it on field and then waiting for the results to see that it was not favorable.

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