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# Coal seam fire area determination using pixel values of the satellite data

*A large amount of coal is locked up in coal seams worldwide, every year, due to uncontrolled coal seam fires (CSF). China and India are most affected due to these fires. Mapping an quantification of these fires requires the spectral characterisation of land use and land cover (LULC) from the satellite imagery. Remote sensing (RS) and Geographic information system (GIS) are useful tools for the assessment of the underground CSF. This paper reports the experiences obtained from the experiments on spectral band of satellite imageries in delineating the thermal regimes of CSF in a coalfield in India. The steps involved in the coal fire data analysis are preprocessing, processing and post processing. The data analyses have been carried out on the satellite data. The changes in LULC have been detected by visual interpretation, image differencing, band rationing and level slicing. The field observations were incorporated in analysis to identify the scope for further improvement in LULC simulations for the reliable modelling, delineation, mapping and monitoring of the CSF. The results obtained from the study depict that shallow depth workings, contiguous panel multi seam workings and the thick seam mining had created directly or indirectly very complex situations in thermal regimes of CSF. The province ratification of the CSF surveillance by LULC depicts that the propagation of the fire is higher in the lateral direction i:e in perpendicular direction of the fire heading.*

## 1.0 Introduction

Extensive underground mine fires is continuing since longtime in Jharia coalfield (JCF) of Indian sub-continent, destroying millions of tonnes of coal. The RS and GIS tools with satellite imageries have been used for the surveillance, identification and transformation of land parcel as land use land cover (LULC) for assessing CSF. The CSF detection, using airborne predawn thermal infrared and daytime multispectral data was done by Prakash, Gupta and Saraf, 1997 after the traditional method of borehole drilling. In their study the pixels values were represented in colour bands and their combinations. Land use alterations that computed by the satellite model obtained from the temperature values of the pixels representing surface and sub-surface CSF. They attempted to estimate the depth of the fire using a linear heat flow equation. The surface and immediate sub-surface characteristics heavily influenced LULC. For any site the natural and artificial integuments under CSF surveillance of land parcels include forests, grasslands, croplands, soil, topography, surface water, groundwater, human structures and urban structures. The design of the land use classes and the monitoring of their changes with temporal interval requires information system. These RS and GIS tools are important in studying LULC patterns, associations and the dynamics. The various land use classes, extracted from the satellite imageries data and verified by the field surveys were classified into twenty five classes. They have been rated by the image processing operations, carried out on LISS III data. The study area comprises about an area of 393 sq km. It is bounded by latitude 23°49'0.63''N to 23°38'36.50''N and 86°08'49.91''E to 86°25'54.92E longitude. The coalfield has proven coal reserves of approximately one billion tonnes in a crescent shaped basin. The major coal bearing geological formations in Jharia coalfield are the Barakar formations.

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## 2.0 Methodology

The RS and GIS tools have been used in the coal fire demarcations in the JCF. It comprises following two phases:

(a) Image processing and enhancements for land use patterns, and

(b) Visual Interpretation of various land use categorized through satellite imagery.

Following data have been used in this analysis:

(a) Indian Remote Sensing (IRS) Linear Imaging Self Scanner (LISS)-III sensor imageries of 21 September, 2012 of Resourcesat I satellite.

(b) Survey of India toposheets at 1:25 000 scale. (published by Survey of India)

(c) Geological map at 1:25 000 scale. (Chandra 1992)

(d) Structural map at 1:25 000 scale. (Chandra 1992)

(e) Fire map at 1:50 000 scale. (BCCL, Dhanbad)

These data were processed in the three phases of preprocessing, processing and post processing. Pre

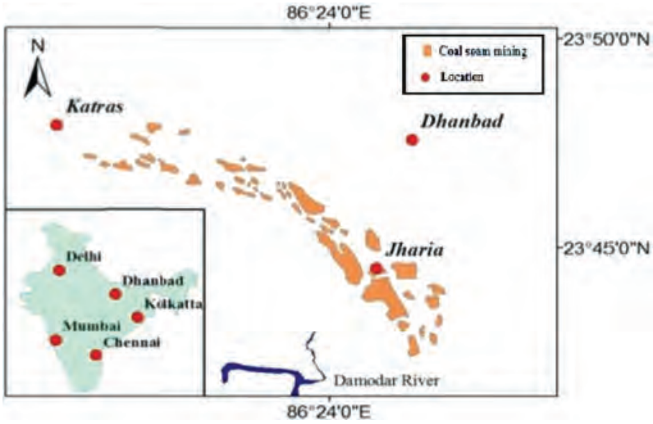


Fig.1 Location of the Jharia coalfield (prepared in Arc map software)

processing techniques require images registration with an authentication level of one pixel or less, as the registration defects for the pixels could be interpreted as LULC change. Registration of images brings all data to the identical scale and geometry. Processing of data involved digital image processing (DIP) techniques contrast manipulation, edge enhancement, colour compositing, density slicing, ratio image generation and principal component analysis (PCA).The post processing illustration of results or maps are: geo rectification, where multi images bring to same scale by geo rectification process. Mosaicing, the various images striches in image by the mosaicing. Density slicing, The range of brightnesses of pixture value is observed for colour coding and better interpretations. Colour display: Displays are the colour coding and IHS transformation. The field data of the JCF has been beneficial in selection of threshold boundary of LULC. The change detected images have been density sliced and

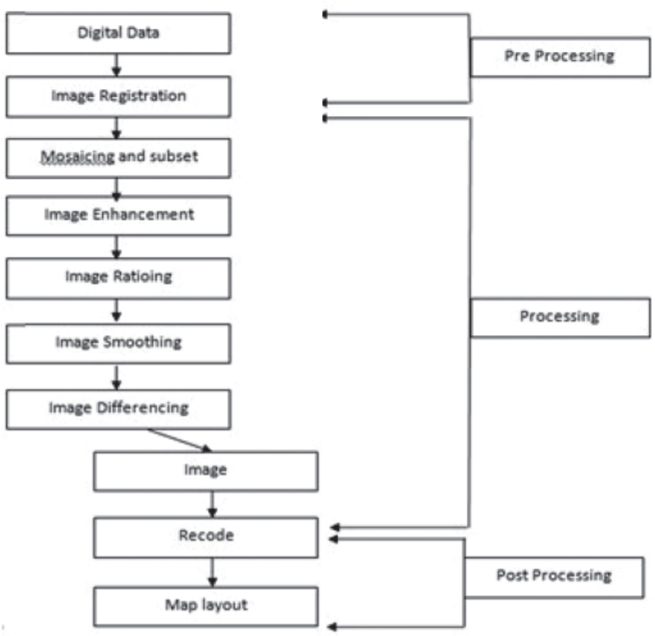


Fig.2 Schematic representation of data row for land use change detection studies in JCF

colour coded to delimit the areas that have undergone maximum change with respect to areas with relatively lesser amount of change. Edge enhancement: The pixel observation is enhanced to get results for boundary and association of feature. The final output images are after processing (Fig.2).

The K-means and maximum likelihood (ML) algorithms or unsupervised and supervised classification and image segmentation methods in which each pixel is processed by the single LULC algorithm unit. The analysis of maximum likelihood (ML) classification on multispectral data by means of qualitative and quantitative approaches. The mean vector and covariance matrices are the inputs of the function for the estimate from the training pixels of a particular class. These information are used by the ML classifier to assign a particular class to pixel by pixel values. A variety of LULC classes were identified in the JCF with the help of enhancement techniques given in Table 1. Land use and land cover classes of land cover and the enhanced colour products derived have been discredited in the table:

LAND USE CLASSES OF LAND COVER

| | L-1 | L-2 |
|---|---|---|
| 1 | Forest vegetation cover | Dense forest |
| 2 | | Open forest |
| 3 | | Degraded forest |
| 4 | | Artificial (forest) |
| 5 | Mining area | Coal quarry |
| 6 | | Advance quarry site |
| 7 | | Mining pit |
| 8 | | Stock |
| 9 | Mining area | Dump |
| 10 | | Barren OB |
| 11 | Agriculture land | Cultivated land |
| 12 | | Fallow land |
| 13 | Waste land | Waste land with or |
| 14 | | Siltation |
| 15 | | Ash |
| 16 | | Barren |
| 17 | | Fly ash pond |
| 18 | Settlement | Urban |
| 19 | | Rural |
| 20 | | Industrial |
| 21 | Water body | Ponds |
| 22 | | Water logged area |
| 23 | | Open scrub |
| 24 | | Barren land |
| 25 | | Sand |

## 3.0 Discussion

Several pixel patterns of LULC are detected in JCF. The vegetative area indices due to pixel values obtained in different bands of satellite images. The classes are classified by pixel values obtained by indices. The classified images

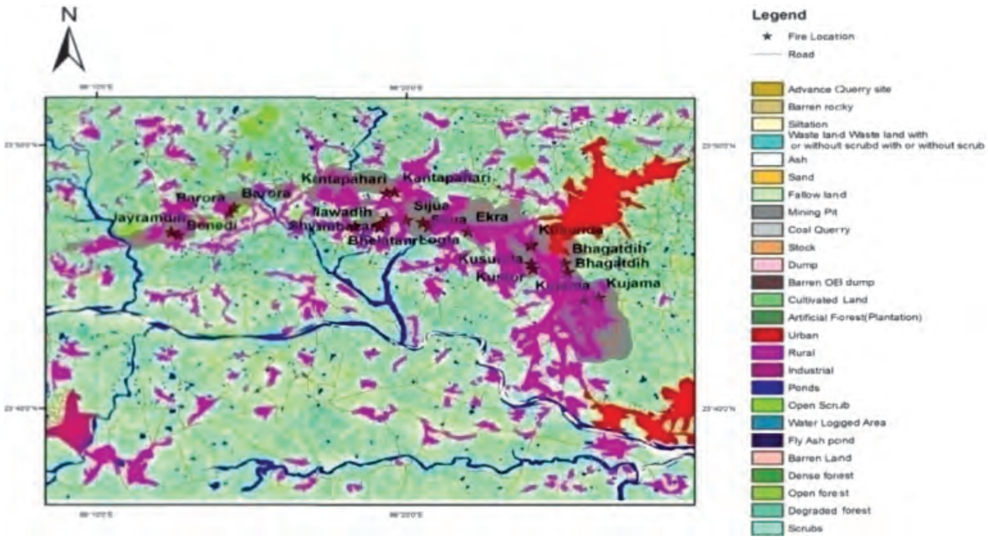


Fig.3 Land use land cover map of Jharia coal field

give LULC classes in the form of pixels values. The various models for interpretation and the classification algorithms employed to classify pixels of RS image. In present study CSF is interpretated through vegetation index in LULC. The low vegetation area give high digital values and high vegetation give low digital value. Non-vegetated or sparsely populated or barren areas show opencast mining. Field data collected for ground truths has been done with attainable ancillary data. The ground control points (GCP) are transferred from topographic maps and the registration of ancillary data sets. The final output map of data is shown in Fig.3.

### 4.0 Conclusion

RS and GIS are useful tools for differentiating and identifying various LULC classes. RS and GIS are beneficial procedure for demarcating the CSF with validations from ground data. A variety of LULC classes were identified in the JCF. Opencast mining severly damages vegetation, which results in decrease in vegetation areas. It appears from satellite data that the descent direction of CSF is dominant in the lateral than the direction of vertical. The numerical system for the level 2 land classes, such a system is not the only method of presenting level 2 land cover and land use information. The extraction of basic thematic information from the land use is the most challenging one with regard to classification automation and transferability. The development of a high accuracy spatial decision support system for utilizing the retrieved results to support planners in making procedure of sustainable development in mines.

### 5.0 References

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