

APPLICATION OF REMOTE-SENSING TECHNIQUE IN GEO-ENVIRONMENTAL STUDY OF SINGRAULI AREA, INDIA

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ABSTRACT

Photogeologically aided Remote Sensing technique has been used to sense and evaluate the geo-environmental attributes' status that is geology, hydro-geology, geomorphology, land use, morphodynamic processes, vegetational cover and mineral-energy resource of Singrauli area, India.

The study was done with the help of Landsat-II Imagery on 1:10,00,000 scale, Aerial photograph on 1:60,000 scale and Survey of India toposheet on 1:50,000 scale with subsequent field check.

The study reveals two dominantly prevailing land system that is Ridge-Valley System of Precambrian Crystalline formation and Plateau-Pediplain system composed of Gondwana Sedimentaries. Plateau-pediplain system control the localization of high potential Groundwater zone as well as Coal reserve of magnitude of 9,200 million ton.

Geomorphological features present in the area help in characterisation of the morphodynamic process operating in the area.

Comparison of generated data with pre-existing data retrieved from earlier remote sensing data product leads to understanding of the temporal qualitative change in various geo-environmental attributes due to brisk anthropogenic activities in the area.

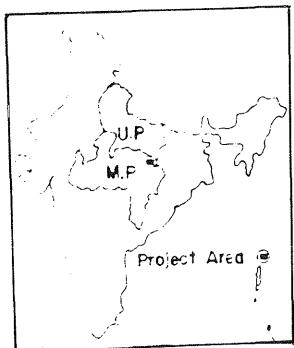
INTRODUCTION

Geo-environment in essence consists of interdependent factors and processes pertaining to Geology, Hydro-geology, Landform, Landuse, Indogenetic and Exogenetic processes and natural resources. Study therefore includes aspects of Geology, Hydro-geology, Landforms, Landuse, Geomorphic processes, Resource evaluation and Anthropogenetic activities, operationally present in the area.

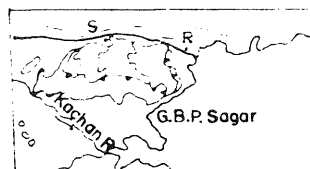
The photo-geologically aided remote sensing technique was adopted for integrated study of the various attributes of the geo-environment of Singrauli area (1,000 sq.km.) lying partly in the states of Madhya Pradesh and Uttar Pradesh, India (Figure-I) with geographical co-ordinates latitude 24°0' to 24°15' N. and longitude 82°30' to 83°0' E.

METHODOLOGY AND DATA AQUISITION

Landsat-II imagery on 1:10,00,000 of bands 4,5,6,7, Aerial photos on 1:60,000 scale, and Survey of India toposheets on 1:50,000 scale were



SINGRAULI
AREA FROM SPACE



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FIGURE-1

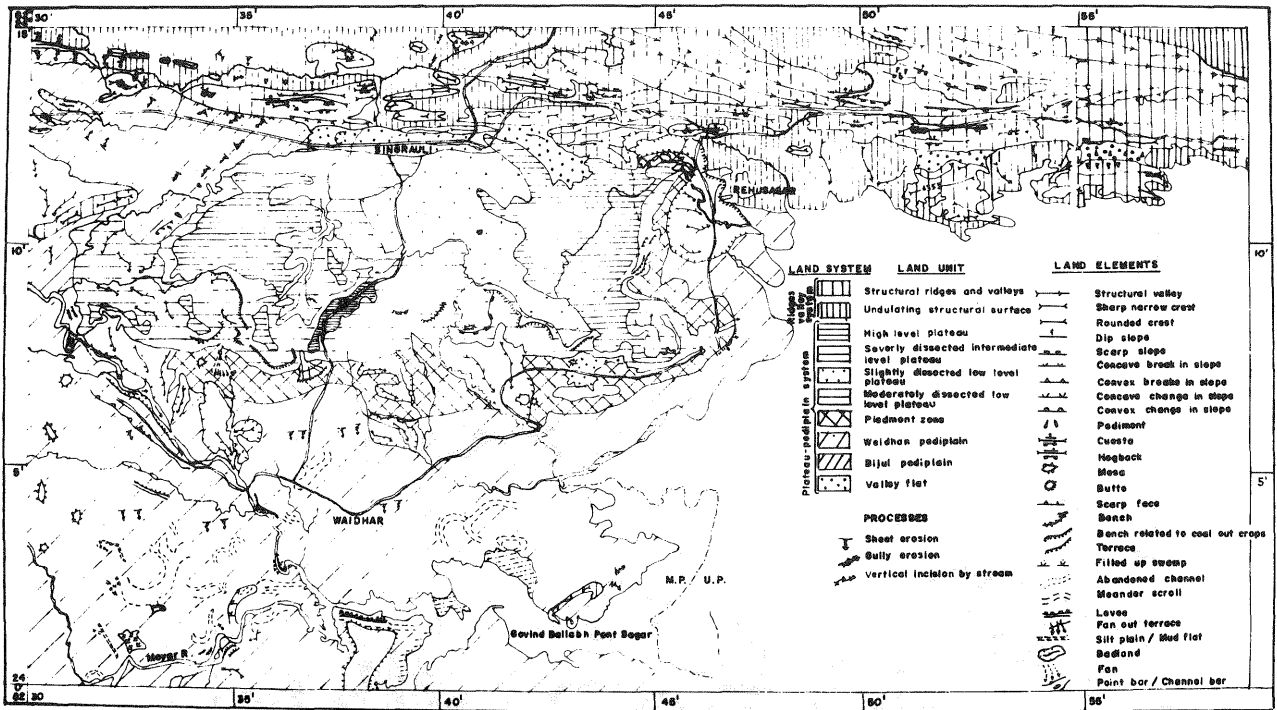


FIGURE-II

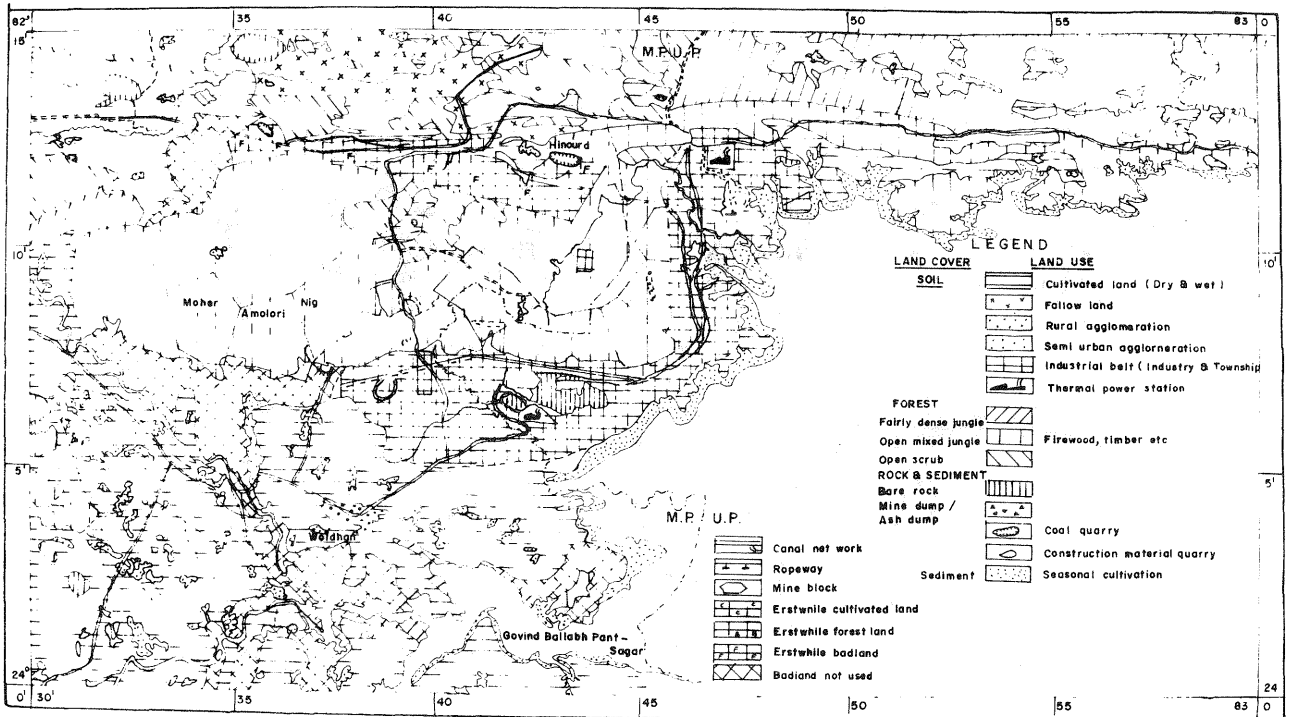


FIGURE-III

used for pre-field interpretation and preparation of thematic maps on geology, geomorphology, hydro-geology, land-cover, land-use, by transferring the interpreted information from aerial photos on to the base map prepared from 1:50,000 scale toposheets, using optical reflecting projector. This was followed by field checks and synthesis of data collected.

DATA ANALYSIS

Older metamorphics, Bijawar meta-sedimentaries and Gondwana sedimentaries are the main litho-unit types found in the area.

Study helped in delineation of land-scape elements (Figure-II) and establishment of its relationship with various uses and anthropogenic processes (Figure-III). The table-I depicts the delineated land system and its relationship with the land-use in practice.

Field-checks subsequent to imagery interpretation and comparative study of toposheet with aerial photos revealed two major land system. Firstly, Plateau-pediplain land system is composed of Gondwana sedimentaries. Four level of plateau exists being flanked in the north by Bijul pediplain and to the west south and east by Waidhan pediplain. The dominant of slope class over this land system is 5° - 15° and 2° - 5° . Plateaus are characterised by escarpment, cuestas, mesas and buttes as well as by deep narrow valleys/gorges with youthful streams exhibiting sub-trellis and sub-parallel drainage arrangement. Pediplain are characterised by older flood plain, relict stream features and buttes. The system is drained by Moher, Matwani, Balia, Kachan and Mayar streams.

Ridge-valley system is another major land system. It is composed of older meta-morphic and Bijawar meta-sedimentaries. Ridges arise above undulating structural surfaces and are interspersed with narrow linear structural valleys. The undulating structural surface show characteristic development of valley flats while the structural valleys show a characteristic development of filled-valleys. The dominant slope class over the system is 15° - 25° and 5° - 15° . The system is drained by Bijul, Mamuar and Murcha streams and their tributaries which exhibit a trellis to sub-rectangular drainage arrangement.

MORPHODYNAMICS

Denudational, fluvio-denudational and fluvial processes are operative in the area which are inferred on the basis of characteristic morphodynamic features such as scarp-retreat, sheetwash, rill-erosion, gully-erosion, fragmentation of plateau, formation of benches, variety of hill slope, gorges, old flood plains and pediplains with isolated buttes, present in the area.

Anthropogenic processes active in the area is manifested by the presence of reservoirs (Figure-I) and surface retention tanks, mine dump heaps, benches and mine pits, canal etc. (Figure II & III).

HYDRO-GEOLOGY

The study also provides information about the structure and physical properties of rocks that govern the infiltration movement and storage of surface and sub-surface water. Majority of the streams exhibit trellis to sub-rectangular or sub-parallel drainage arrangement seemingly due

to influence of fault and fracture with which geological formation of the area are interspersed with.

Geological formation in the area have in general low to very low porosity and permeability and hence are normally not favourable for infiltration and storage. But owing to their having fracture and faulted nature the secondary porosity improves permeability considerably to promote moderate infiltration, transmission and storage of groundwater. Fracture and faults have favoured quick and significant movement leading to rapid migration of groundwater, its re-emergence as spring and creation of sub-artesian condition.

Based on geology, soil, vegetal cover, land forms, processes and slopes, the zone of surface run-off, zone of infiltration and zone of maximum infiltration, storage (aquifers) were demarcated and the area was divided into six zone varying from non-potential zone to very high potential zone. Structural ridges constitutes the zone of non-potential area where as zone of very high potential includes Waidhan pediplain and Bijul pediplain.

RESOURCE EVALUATION

Resource evaluation was carried out to ascertain the water, mineral and forest resource status.

Water Resource :

There is an overall adequate water reserves in the present areas. The surface water is available from Bijul river, Kachan, and Mayar rivers, Matwani, Balia, Murcha and Mamuar sub basins. An approximate yield, computed empirically, from Matwani, Balia Murcha, Muher indicates the availability of 38.2 m.cu.m. per annum in the southern part of the area. No estimation was possible for north flowing. Position of groundwater reserve is fairly encouraging. Excepting the ridge-valley land system the sub-surface water reserve over the rest of the land unit is high to very high under shallow to deep aquifer condition. The most promising reserve available is in the north central part where semi-artesian condition exists. The plentiful available ground water at shallow depth is indicated by large number of shallow dug wells.

Mineral Resource :

Coal is the most dominant mineral resource of the area. About 9,200 million tons of coal reserve under proved, indicated and inferred category found contained in the plateau-pediplain system.

Forest Resource :

Figure-III shows the area having forest cover . Table-II shows the present and past status of forest resource alongwith the land units they cover.

SUMMARY AND CONCLUSION

Visual Analysis of remote sensing data product led to identification of two major land system. The plateaus are the store house of coal reserve and also possesses good aquifers which can meet the industrial requirements. The two land system owned sufficient hydel power potential from the streams draining them. The water supply can be made available in reasonably good amount from the area to the south in the vicinity of

contact between Gondwana sedimentaries and metamorphic rocks where semi-artesian condition exists and aquifer has got good recharge. Bijul and Waidhan pediplains have attributes which favour the expansion of urban and industrial centre and have a good agriculture potential.

However, qualitative change in the various geo-environmental attributes has taken place in the area. An anthro-pogenetically modified geology, land-elements, processes, vegetation, soil etc. has resulted at a brisk pace due to mining and industrial activity taking place over the plateaus, pediplains and to some extent undulating structural surface. Mining activity would involve degradation of plateau into mine-dump heaps, benches, pits etc. with a disarrangement and modification of existing drainage pattern and temporary damning of Motwani, Balia and Moher stream. The newly drainage pattern that would develop over the excavated earth work would initiate accelerated sheetwash, rill erosion leading to siltation problem. The enormous loss of forest wealth due to mining and industrial activity is well documented (Table-II).

EXPLANATION OF FIGURE

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|------------|--|
| Figure-I | Location map |
| Figure-II | Gemorphological map showing various Landscape element and morphodynamic process. |
| Figure-III | Land cover - Landuse map with evidence of anthropogenic activities. |

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TABLE-I

Existing Relationship between Geomorphology and Landuse

Land System & Land Unit 1	Land Elements, Relief, slope, soil 2	Morphodynamic processes 3	Suitability 4	Present landuse 5
1. Ridge Valley system	Cuesta, Hogback strongly inclined (5°-15°)	Sheet wash, sliding weather- ing, fluvio denudational	Forestry, terrace cultivation	Forest, dry cultivation
(a)Ridges	Steeply slopping (about 15°) narrow sharp crest or rounded crest with break in slopes, skeletal soil			
(b)Valleys	Strongly inclined (5°-15°) at places gently undulating (2°-5°) filled- Valley or flats; immature soil, moderately narrow and linear in extent, gently undulating to plain relief amplitude	Sheetwash, gully erosion, fluvial proce- sses. Through stream incision, fluvio-denu- dational	Forest, Cultivation, constraints in urban development and settle- ment, suit- able for tube well irrigation & gravity irrigation	Cultivation
(c)Undulating structural surface	Gently inclined, slightly sloping, gently undulating relief amplitude, break in slopes, changes in slopes, benches, valley flats, immature impersistent soil.	Denudational processes like sheet wash, rill and gully erosion, fluvial processes through vertical incision	Forest cultivation (Mechanised) transport good for construction of settle- ments and industries, storage tanks	Cultivation industrial urban agglomera- tion roads & rails lines, reservoire, waste disposal sites
2. Plateau- Pediplain system	Top with a slight slope (0°-2°) scarp face, benches, slope over 25° on the scarp faces, valley flats, mesa, butte skeletal soil, very thin, mode- rately thick along valley flats	Denudational processes like sheet wash, creep, fluvio denudational processes like gully erosion bench formation fluvial process through deep incision, anthro- pogenic proce- sses(mining)	Forestry, construction material, coal mine development, dumping of mine waste	Development of coal mine, defor- estation, cultivation along valley flats, industrial colonies, semi urban agglome- ration
(a)Plateaus (4 Levels)				

TABLE-I (Contd.)

Land System & Land Unit 1	Land Elements, Relief, slope, soil 2	Morphodynamic processes 3	Suitability 4	Present landuse 5
(b)Waidhan Pedeplain & Bijul Pediplain	Pedimont Zone colloviaal apron, older good plain, alluvial flats etc. Mesa, Butte Pediment,imper- sistant immature soil development, slightly plain to slightly sloping, relief amplitude of less than 25 m, silt plain	Denudational processes like sheet wash, rill erosion, fluvio dedudational processes and fluvial proce- sses and very dominant action of rese- rvoir, other anthropogenic processes	Plantations, cultivation (ideal) best con- dition for construction of settle- ments, roads, railways, surface storage tanks, canals, groundwater development	Cultivation, rural and urban agg- lomeration, industries, its leased colonies, reservoir, canals, surface storage tanks, tube wells (Shallow) waste disposal site

TABLE-II

Status of Forest Resources

Type of forest	Land unit	Present status (Area)	Past status (Area)
Dense Mixed Jungle	Ridges and valley	100 sq.km.	150 sq.km.
Open Mixed Jungle	Structural surface	Nil (Occurs as open scrubs)	35 sq.km.
Dense Mixed Jungle	Plateau	Nil	84 sq.km.
Open Mixed Jungle		6 sq.km.	60 sq.km.