Geomorphological Mapping for Delineate Hydrogeomorphological aspects in Jhabua Tehsil using Remote Sensing and GIS Technique

Anjali Gupta
Research Scholar
Department of Geology
Govt. MVM Collage Bhopal, India

V. L. Punwatkar
Professor & Head of Dept.
Department of Geology
Govt. MVM Collage Bhopal, India

Abstract

This research article is for indicating ground water prospect zone deals with the preparation of Integrated Ground Water Resource. Water availability for development of the area is the central issue in drought prone areas. The resultant increase in the productivity can upgrade the quality of life of people. Water and vegetation in a land unit for providing an answer to lighten drought, moderate floods, prevent soil erosion, improve water availability and increase crop, fodder, fuel and fibre production on a sustained basis. Over this period, Jhabua witnessed some severe droughts prone area. The processes of deforestation and land degradation have caused broad range of disorganization of water management systems. The recurrence of drought increased significantly and except collective measures are initiated on a permanent basis the situation will become severe in future. The area is selected to demonstrate the capability of high resolution satellite data in Hydrogeomorphological mapping at tehsil level. This study area is located in Survey of India toposheet Nos. 46J/5, 46J/6 46J/9, and 46J/10. Jhabua tehsil with area of about 1028 sq.km is lies between 220 45'35.88" North latitude and 740 35'10.06'' East longitudes. Hydrogeomorphological mapping was carried out on 1:50,000 scale using Indian Remote Sensing Satellite (IRS-1) of LISS-III with 23.5 m spatial resolution satellite data. The land form of this district is created by structural and denudational origins. The main hydrogeomorphic units mapped are alluvial plain, alluvial plain with sand cover, valley fills intermountain valley/basin, structural hills, residual hills, buried pediments, linear ridges along with lineaments. Each geomorphic unit is assessed for probable ground water potentiality. The prepared hydrogeomorphological map has been digitized in Arc map in GIS environment. This will result in significant saving of time and cost.

Keywords: Hydrogeomorphology, Geomorphology, Ground Water, Remote Sensing, GIS

I. INTRODUCTION

Water is the most essential requirement for human life. The growth of any area is dependent on its natural resources of which land and water form the core of ecological system. Ground water constitutes a major portion of the earth's water circulatory system known as hydrologic cycle [1]. In recent year the application of remote sensing and GIS enhance the technique for hydrogeomorpholical mapping. The satellite imagery provides integrated information on different topographical factors for recognized the ground water study. In the present study the ground water prospect zones in Jhabua tehsil were delineated using remote sensing and GIS techniques. Hydrogeomorphological maps have a helpful to study of exploration hydrogeology, engineering geosciences, geotechnical engineering and planning. The role of geomorphology is important to correctly evaluate groundwater resources. This study highlights methodological guidelines for the preparation of Hydrogeomorphological maps to support groundwater conceptual modeling, as well as for environmental sustainability issues. The awareness on groundwater and accurate way of improving surface water circulation can provide by Cartographic techniques. With the help of satellite imagery and analysis of study area thematic maps were prepared such as topographic, geological, geomorphological and hydrogeological maps. This helps in concentrating the field efforts in areas where greater potential exists and eliminating other zones, thus reducing the cost and time involved in exploration procedures [11]. The advent of Geographical Information Systems (GIS) has added new vistas in the field of ground water resources mapping and management. It helps in the integrating remotely sensed derived data with ancillary data to have more precise and correct information about various factors involved in the ground water resources management.

II. STUDY AREA

The area selected for the present study constitutes a part of Jhabua District of Madhya Pradesh and cover an area of 1028 sq.km. The study area Jhabua tehsil is falling in survey of India toposheet no's 46j/5, 46j/9, 46j/10, 46j/13, 46j/14. The area lies between 22^0 45'35.88" North latitude and 74^0 35'10.06'' East longitudes. Physiographical the area is characterized by undulating topography. Jhabua in surrounded by one of the dense forest areas of Madhya Pradesh. Over the last four to five decades, more than 80 per cent of its forests were extremely degraded. The causes included intensive cultivation on uplands and clearing of forests

by wood contractors. Loss of forests led to loss of land productivity, diminishing employment opportunities, and outward migration of local people. The impact was felt more deeply by the tribal's who constitute 83 per cent of the district's population, and whose survival is closely linked to forests. Over this period, Jhabua witnessed some severe droughts and famines. The processes of deforestation and land degradation have caused extensive disorganization of water management systems. Migration in search of employment and sustenance swelled, during the 1990s, almost 65 percent of the local population was migrated out.

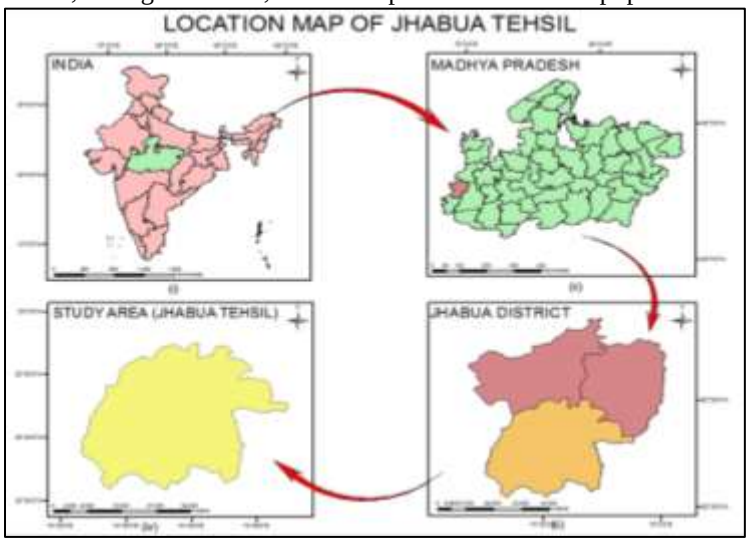

Fig. 1: Location map of Jhabua tehsil

III. OBJECTIVE

- To prepare hydrogeomorphological maps on 1:50, 0000 scale using satellite data.
- To delineate ground water potential zones by assessing the geomorphological units on 1:50,000 scale.
- Preparation of integrated ground water resources map derived from hydrogeomorphology

IV. DATA EVALUATION AND METHODOLOGY

Survay of India toposheets no. 46j/5, 46j/6, 46j/9, and 46j/10 on 1:50,000 scale and Indian Remote Sensing Satellite (IRS-1) of LISS-III with 23.5 m spatial resolution in digital arrangement were used for hydrogeomorphological map preparation and quantitative analysis has been done. The false colour composite satellite image has been visually interpreted by using standard interpretation keys such as colour, tone, texture, pattern of drainage, shape and topography etc. The SOI toposheets and satellite data were geometrically rectified and georeferenced to world space coordinate system with digital image processing software (ERDAS IMAGINE 2011), and Digitization work by (ArcGIS 10). All the conventional information such as geological, geomorphological, was used in the finalization of the hydrogeomorphological maps.The detailed hydrogeomorphic analysis is carried out in order to understand the geomorphic pattern.

Onscreen interpretation is carried out delineating different geomorphological units/landforms, lithological formations, geological structures and hydrogeomorphological map is prepared by integrating the above said parameters (NRSA 2008).

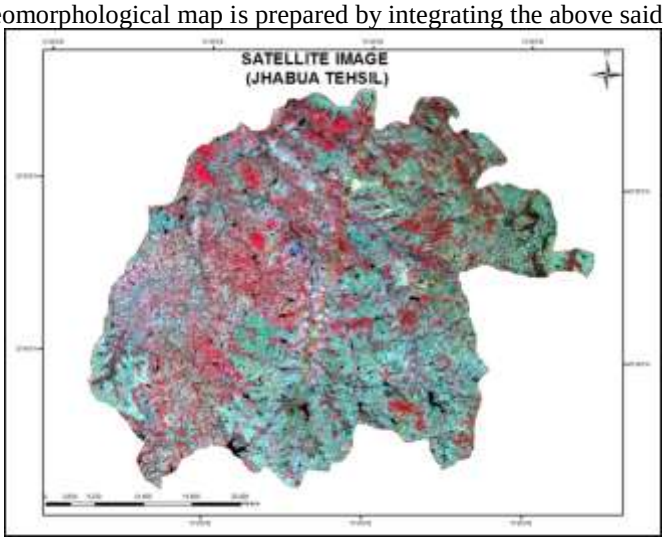

Fig. 2: Satellite image of Jhabua tehsil

V. RESULTS AND DISCUSSION

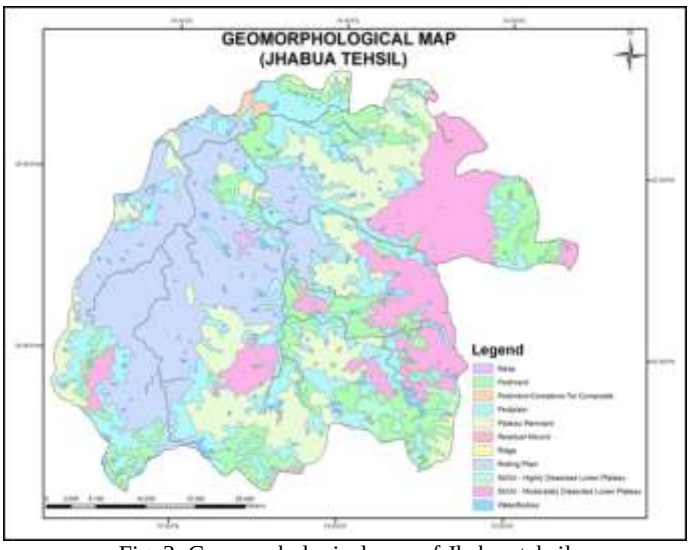

Fig. 3: Geomorphological map of Jhabua tehsil

Present paper on thematic maps generated using high resolution satellite. In the present study hydrogeomorphological mapping is carried out using (IRS I) LISS-III satellite data. The landforms in the study area are broadly divided into two categories namely, denudational and structural landforms. As the depth of weathering and nature of soil cover plays a major role in the ground water prospecting. There are, pediplains, pediment, rolling plain residual mound under denudational origin and ridge moderately dissected lower plateau, highly dissected lower plateau, mesa are structural origin geomorphic units were delineated. The description of each hydrogeomorphic unit occurring in this area is as follows.

A. Pediments

These are being constituted by erosional surface which extent downwards from hill to neighboring basin consist of phylite, quartzite showing gentle slope sparse vegetation. Rock floor with a very thin or low soil cover has been identified on pediments the lineament intensity is low. Drainage density is moderate and it is characterized by very gentle slope vary from 5 to 10 degrees. Therefore these are poor potential units from the point of view of ground water occurrence.

B. Pediplains

The continuous process of pedimentation occur formation of pediplains. Pediplains are almost flat area with vary gentle slope ranging from 1-5 degree. The altitudinal variation is relatively high for rolling plain and is about 5 -10 m. In this area are exists irregular dissected portions with a number of gully are present. The pediplain with sedimentary rocks exposures (Upper Cretaceous formations) are to be found in the south-western part of the area. This formed due to severe weathering under semi-arid climatic conditions, representing final stage of the cyclic erosion [6, 7]. These are identified in the imageries with grey tone. Groundwater prospects in this unit good due to the moderate thickness (15-20 m) weathering materials [2]. Pedipalin are also found in the eastern part of the area.

C. Plateau

This landscape unit is dominant in the major part of the northwestern part of the study area. The land of this unit is giving size to a terrain consisting of flat-topped ridges and steep scarps. This unit has elevation range of 450 to 500 m above msl and occupy 34.6% of the total area. Morphometric attribute, of this unit include steep slope (>100), rapid runoff, high drainage density. Groundwater potential in this unit is very poor. The runoff water can be arrested in the form of check dams and other suitable measures can be taken to boost the pasture, farm forestry and horticulture in the area.

D. Mesa

A mesa is smaller in area than a plateau. This creature is isolated, flat-topped hill or mountain with sharp sides. A mesa has a surface area of less than 4 square miles (10 square kilometers). Mesa is resistant landforms and groundwater prospect in these geomorphic units is poor

E. Linear Ridge

These are identified by their narrow linear trends. These mainly include elongated ridges. Linear ridges are generally trending south east direction these are located in pedment. These are acting as water barriers. These are structurally controlled having steep

slope and characterized by high runoff and low infiltration. This unit has been characterized as poor to nil ground water potential zones.

F. Lineaments

A lineament is defined as a large-scale linear feature, which expresses itself in terms of topography, an expression of the underlying structural features. From the groundwater point of view such features may include, valleys controlled by faulting and jointing, hill ranges and ridges, displacements and abrupt truncation of rocks, straight streams and right angles off setting of stream courses etc., [9]. A lineament is a regional scale linear or curvilinear feature, pattern or changes in pattern that can be identified in a data set and attributed to a geologic formation or structure [8]. The linear features can be measured and treated quantitatively like measurements of other geological properties, but it is necessary to use formal statistics that reflect the circular nature of the directional data [3]. Lineaments are linear fractures commonly associated with dislocation and deformations. They provide the pathways for groundwater movement and are hydrogeologically very important [10]. Lineaments are important in rocks where secondary permeability and porosity dominate and inter-granular characteristics combine in secondary openings influencing weathering, soil water and groundwater movements. The fracture zone forms an interlaced network of high transmissivity and serves as groundwater conduits in massive rocks in inter-fracture areas. The lineament intersection areas are considered as good groundwater potential zones. The combination of fractures and topographically low grounds can also serve as the best aquifers horizons [4, 5]. A numerous lineaments were marked in this study area. The lineaments are trending in the directions of northeast to southwest, north to south A few of them east-west direction also. The distribution of lineaments is maximum in the western part where as minimum are found to be eastern part. (Fig.4).

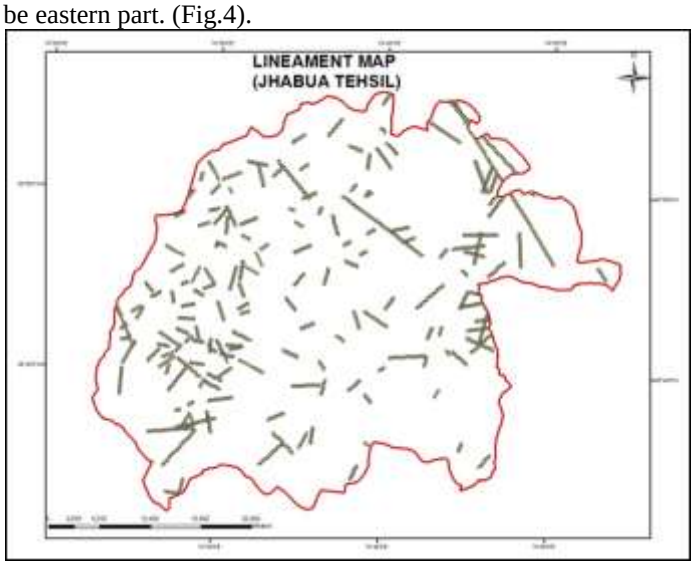

Fig. 4: Lineament map in Jhabua tehsil

Finally, Jhabua environs has been classified into three zones on the basis of their groundwater potential zones such as excellent, good, moderate, poor, yield characteristics along with geological, geomorphological and hydrogeological information (Fig.5).

On the basis of hydrogeological, hydrogeomorphological studies, the study area can be broadly classified into the following ground water potential zones:-

- Excellent to Good zone.
- Good to moderate
- Moderate to poor potential zone.
- Poor to nil or very poor potential zone.

1) Excellent to Good zone: This category include infilled valley. These features are good recharging area. These are characterized by low drainage density, moderate lineament density with for intersection points with drainage having good frequency distribution yield of wells.
2) Good to Moderate: This includes deeply weathered pedeplain and moderately weathered pediplain having thickness 5 to 10mtr. And 1-5mtr. Thick weathered zone respectively. Moderate slope supporting good vegetation, drainage density low the well frequency is high and lineament intersection are high making this unit good to moderate and moderate to good potential zone of ground water.
3) Moderate to poor potential zone: - This includes shallow weathered buried pediplain consisting of 5 to 1 m. Thick weathered zone supporting good cultivation having gentle slope, the lineaments are well distributed. Fracture and joints are common. This unit categorized under moderate to poor potential zone of ground water.
4) Poor to nil or poor potential zone:- This includes denudation hill and linear ridge which are the poor to nil potential zone with steep slopes, high drainage density and low infiltrations where the lineament intersections are present may be considered as poor and poor to nil ground water potential zone of these units.

Fig. 5: Hydrogeomophological map of jhabua tehsil

VI. CONCLUSION

The Jhabua tehsil exhibits various hydrogeomorphological conditions due to its location, topography and geology. The main hydrogeomorphic units are divided into areas occupied by valley fills, pediplains, pediments, highly dissected plateau and denudational hills, and structural hill. Excellent to good ground water prospect zones cover about 10% area of the district, whereas rests of the area constituted by denudational and structural hills has moderate to poor and nil prospects.

Use of Remote Sensing and GIS technology is very useful for the preparation of ground water prospective areas mapping & management plan on a scientific basis. The information generated on prospects, will help the planners and decision makers for devising sound and feasible ground water development plans.

The Indian Remote Sensing satellite (IRS -I LISS-III) data with a spatial resolution of 23.5m can be enlarged even up to 1:25,000 scales. With the help of high resolution data, development of rural settlements, drainage and road network is updated. The boundaries of all geomorphic units are drawn more precisely. With the advent of high resolution satellite data, site-specific recommendations for ground water exploration can be given at cadastral level for effective management of ground water resources at smallest possible revenue boundary.

Visual interpretation of IRS 1A Satellite imageries provided information related to the geology, geomorphology, and lineaments interpretation was helpful in knowing the nature and water potentiality of different geomorphic units. The composition of materials of landforms, and there inferred rechargebility and other hydrogeomorphic characteristics for identifying the groundwater potential zones.

Geologically, the area is occupied both hard and sedimentary formations. The hard rock's include gneisses, quarzites. In the sedimentary formations comprised of sandstone, limestone, etc.

Hydrogeomorphologically, there are investigated areas occupied by denudational hills, structural hills, Pediments, Pediplains. By studying the hydrogeomorphological conditions of the area, it is possible to interpret the groundwater potentiality. Most part of the area Good to moderate, while rest of the area plateau and pediments poor, pediplains having good groundwater potential zones. Bore well are recommended the lineaments and intersections areas. In addition to that electrical resistivity survey is required for to locate the exact location of good bore wells/tube wells sites in the areas.

REFERENCES

[1] B. S. Chaudhary, M. Kumar, A.K. Roy, and D.S. Ruhal 1996. Application of remote sensing and Geographic Information Systems in Ground water Investigations in Sohna block, Gurgaon District, Haryana (India). In: International Archives of Photogrammetry and Remote Sensing Vienna, Vol. XXXI, Part B6, pp.18-23.
[2] Prakash, S.Ravi and Mishra,D (1993). Identification of groundwater prospectives zones by using remote sensing and geoelectrical methods in and around Saidnagar area, Daker block, Jalaum District, U.P.j. Indian Soc.Remote Sensing,21(4):pp. 217-227.
[3] R.F. Cheeney (1983) Statistical methods in Geology, George Allen Unwind Ltd., London, 169p.
[4] Karanth, K.R (1989). Hydrogeology. Tata -McGraw Hill Pub.Co.Ltd., New Delhi, 458p.
[5] N. Subba Rao (1992). Factors affecting optimum development of groundwaters in crystalline terrain of the Eastern Ghats, Visakhapatnam Area, Andhra Pradesh, India. J. Geolo.Soc.India, 40(5): pp.462-467.
[6] L. C. Knig (1950). The study of the world plain lands. A new approach in geomorphology, Quart. Geol. Soc., London,106: pp. 101-103.
[7] Sparks B .W (1960). Landforms in arid and semi-arid climates. Geomorphology 2nd Ed., Longman Group Ltd., pp.335-341.
[8] M. N. Qureshy and W. J. Hinze (1989). Workshop Overview. Proc.Joint Indo -US Workshop on Regional geophysical lineaments-their tectonic and economic significances, Mem.Geol.Soc.Ind., Bangalore, No.12, pp.3-10.
[9] Y. Ramesh (1990). Geomorphic Studies in Upper Gostani River Basin with Special References to Borra (Karst) Caves Visakapatnam District, A.p., India. Ph.D. Thesis, Andhra University, India, 131p.

[10] K. Sankar, M.S. Jegatheesan and A. Balasubramanian (1996). Geoelectrical Resistivity Studies in the Kanyakumari District, Tamil Nadu, J. of Applied Hydrology Vol.IX, Nos 1&2, pp.83-90.
[11] B.V.M. Rao Toleti, B. S. Chaudhary, K. E. Mothi Kumar, G. P. Saroha, Manoj Yadav, Ajeet Singh, M. P. Sharma, A. C. Pandey and P. K. Singh, Integrated ground water resources mapping in Gurgaon district, (Haryana) India using Remote Sensing and GIS Techniques by Geospatial World September 1, 200 Scientists, Haryana State Remote Sensing Application Centre (Deptt. of Sci. & Tech., Govt. of Haryana) CCS HAU Campus, Hisar 125 004, Haryana, India Phone (01662) 31045-47