HYDROGEOMORPHOLOGICAL STUDIES FOR
GROUND WATER PROSPECTS USING IRS -1D,
LISS III IMAGE, IN PARTS OF AGRA DISTRICT
ALONG THE YAMUNA RIVER, U.P., INDIA

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ABSTRACT

In the present study Hydrogeomorphological survey has been carried out along the Yamuna River in parts of Agra district U.P, India. The satellite image of IRS-1 D, LISS III has been used to delineate the hydrogeomorphological units. The base map has been prepared from survey of India toposheets on 1:50000 scale. The study is aimed to assess and to delineate groundwater potential zones for future development and exploration. The different hydrogeomorphic units and features identified using remote sensing data and conventional information with limited ground truth are alluvial plain, flood plain, flood prone area/palaeochannels and ravines etc. The groundwater potential of each geological and geomorphologic unit has been evaluated in order to obtain a complete hydrogeological picture of Agra district. The final result shows the prosperous groundwater zones in the study area and can be helpful in better planning and management of groundwater resources especially in hard rock terrains.

Key Words : Hydrogeomorphology, Yamuna River, Agra, Satellite image.

INTRODUCTION

Agra district of Uttar Pradesh is located along southern fringe of the Indo-Gangetic plain faces severe scarcity of ground water. The available surface and groundwater resources are inadequate to meet entire water requirement for different purposes and the demand for water has increased through years. Thus it has become inevitable to identify the groundwater prospective zones in Agra to meet the need. Groundwater being subsurface phenomenon, its identification and location is based on indirect analysis of some directly observable terrain features like geological structures, geomorphic features and their hydrologic characters1. During recent years the extensive use of satellite remote sensing in conjunction with sufficient ground truth have made it possible to identify various ground features such as geological structures, geomorphic features, and hydraulic characters. Remote sensing with its advantages of spatial, spectral and temporal availability of data covering large and inaccessible areas within short time has become a very handy tool in exploring, evaluating, and managing vital
groundwater resources. The remote sensing data helps in fairly accurate geomorphological analysis and identification and delineation of land features. Modern remote sensing techniques facilitate demarcation of suitable areas for groundwater replenishment by taking into account the diversity of factors that control groundwater recharge. Studies have been being carried out in this direction by many workers such as: but no major work on this aspect has so far been carried out in the areas in the study area.

Objective of the study

The objective of the present study is to assess and to delineate groundwater potential zones in Agra District for future development and exploration of groundwater potential zones in the study area.

Study Area

The study area is a part of Indo-Gangetic alluvial plain lies between north latitudes of 26° 44' and 27° 25' North and longitudes of 77° 26' and 78° 32' East covering an area of about 4027 sq.km. Fig. 1 shows the location of study area.

![Fig. 1 : Location map of study area (Agra district, Uttar Pradesh)](image)

Geological and Physiographic setup

Geology

Geologically the study area is a part of Indo-Gangetic plain. The major part of the area is covered by Gangetic alluvial deposit of the Quaternary period, mainly comprises gravel, sand, silt, clay and kankar, overlying the rocks belonging to the Vindhyan Super Group. The geological sequence of the area based on the work carried out by is given below and followed in the present work.

<table>
<thead>
<tr>
<th>Table 1 : Geological sequence of area under study.</th>
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<tbody>
<tr>
<td>Quaternary</td>
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<td></td>
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<tr>
<td>Precambrian</td>
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The lower Rewa sandstone occurs as discontinuous strike ridge in the southwest of Bayana, are hard, compact, fine grained, bedded white to pinkish in color and less ferrigenous than that of overlying upper Bhander sandstone. The upper Bhander sandstone exhibits shale with intercalation at different levels. The sandstone is reddish in color with characteristic white to fawn color spots. The study area comprises a large amount of alluvium deposit and occurs as lenticular beds and show rapid variation both horizontally and vertically and essentially composed of sand silt, clay and gravel. On satellite image of IRS-1D, LISS III, this unit is identified by its white tone and medium texture.

Physiographic setup

Physiographically Agra district is divided into five divisions, namely Khaddar lowlands, Trans-yamuna plains, Yamuna uplands, Southwestern uplands and the Yamuna – Chambal ravines of the two major physiographical divisions of India (Peninsular region and the great Indo-Gangetic alluvial plains).

Drainage

Three perennial streams in the area are Yamuna, Utangan and the Chambal. The river Yamuna and its tributaries drain the region and follows the general slope and relief features and roughly follow NW to SE direction.

Soils

The soil of the region is alluvial and may be placed into two types namely as Khaddar and Bhanger. The soil of Agra district is further categorized into five types as sandy soil, sandy loams, loamy soil, clayey loams and clayey soils.

Climate

The study area lies in the region of tropical monsoon climate influenced by the two distinct air currents known as the NE and the SW monsoon which are further subdivided as:

- The season of NE monsoon
  - A. Cold weather season (Jan-Feb)
  - B. Hot weather season (March-mid June)

- The season of SW monsoon
  - (i) General rain (mid June-mid Sept)
  - (ii) Retreating monsoon (mid Sept-mid Dec.)

The mean annual rainfall ranges between 600 and 650 mm.

MATERIAL AND METHODS

The geocoded standard false color composite (FCC) has been generated using spectral band 2, 3 and 4 from IRS-1D-LISS III data acquired on March 28th 2003. The Path-Row of the data is P028 and R048 respectively. The spatial resolution of the IRS-1D-LISS III data is 23.5 meter. The FCC obtained was subsequently used to classify the hydrogeomorphological units of the area using visual interpretation techniques such as tone, texture, association etc. Different Hydrogeomorphic units have been manually digitized and final hydrogeomorphic map prepared. The Survey of India topsheets on 1:50,000 scales (54 I/3, 54 I/4, 54 I/7 and 54 I/8) and field observation data have also been utilized to obtain the information on the hydrogeomorphic features of the study area. These Hydrogeomorphic features have been identified as excellent, very good, good and poor groundwater prospecting zones.

RESULTS AND DISCUSSION

The hydrogeomorphic units and other associated features have been identified and mapped through visual interpretation of the FCC generated from IRS-1D LISS III image. The hydrogeomorphology of the study area is described below.
Hydrogeomorphology

The hydro geomorphic unit’s viz., ravinous land, sand bar (river sand), paleochannels, younger alluvium, recent flood plain and older undulating surfaces have been identified and mapped along the river Yamuna of the study area. The mapped units are briefly discussed and illustrated in Fig. 2.

Fig. 2 : Hydrogeomorphological map of Yamuna River in parts Agra District (study area).

Ravinous Land

The ravinous land formed as a result of intense gulling and certain upliftment of the area affecting unconsolidated material, results in the formation of perceptible channels. The ravines are dominantly present on either side of the yamuna and chambal rivers. The ravines are identified on IRS-1D, LISS III images by their light yellow tone, coarse texture and elongated shape with dendritic drainage pattern. The groundwater prospect in this zone is poor.
Sand Bar (River Sand)

Abundant longitudinal sand bar and point bar have been identified along the river Yamuna. The sand is well-sorted and well-rounded represent the alluvium stored temporarily along the river channel. Sand bar is identified by light blue tone, fine texture and lenticular to elongated shape. These sand bodies are normally flooded during the monsoon and during dry season however, they serve as highly fertile piece of land for cultivation. The extremely shallow water table excludes the need of irrigation.

Paleochannels

Paleochannels are old river courses buried by subsequent sedimentation and identified on IRS-1D, LISS-III images by their contrasting dark tone in a characteristic winding fashion in association with cropping pattern. The paleochannels are generally potential reservoirs for groundwater exploration and their identification is useful in flood mitigation. Several paleochannels are identified adjacent to the Yamuna river course on either side. The soil in these paleochannels has more moisture content as compared to the adjacent areas due to groundwater flow in these paleochannels. Groundwater prospects in these buried channels appear to be excellent because of hydrophilic nature of alluvium, retention of flood water and presence of vegetation and shallow to very shallow water table.

Younger Alluvium

The younger alluvium refers to the recent alluvium, deposited by the rivers mainly confined in the vicinity of the main river channels. The younger alluvium is identified by its characteristic dark red tone due to presence of high moisture content and abundant vegetation. Most of the parts of the younger alluvium coincide with younger terraces, which are the recent flood plain of the river Yamuna, maintained and modified each year by the floods.

Older Alluvium

The older alluvium is upland area lying at some distance from the main river channel. This unit is characterized by deep water table and also not reachable by the flooded water. This unit is widely marked by the wastelands in the form of saline land and ravinous land along the river Yamuna and their tributaries.

Older Undulating Surface

The land which is devoid of forest and vegetation cover occupies relatively higher topographic location, identified as old undulating surface (T1) by its light yellow to greenish blue colour, fine to mottled texture and irregular shape near Fatehabad and Bah tehsils of Agra district.

Recent Flood Plain

This is the youngest unit and includes various features formed by fluvial action, consisting mainly of sand, silt and clays which facilitate channel bed infiltration. The water level is shallow and groundwater prospects are found to be good. The various geomorphic units and their ground water bearing prospects are summarized and given in Table 1.

CONCLUSION

The present study reveals the usefulness of remote sensing techniques for the hydrogeomorphological mapping and in delineating the groundwater prospecting areas for water resource development plan. The study shows that the hydrogeomorphological units such as paleochannels and younger alluvium have excellent to very good ground water prospects respectively where as sand bar and younger flood plain have good groundwater prospects in parts of Agra district along the Yamuna river.
Table 2: Groundwater prospects of various geomorphic units

<table>
<thead>
<tr>
<th>Geomorphic Units</th>
<th>Description</th>
<th>Water Prospects</th>
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<tbody>
<tr>
<td>Older alluvium</td>
<td>Characterized by deep water table, wastelands, (Saline land and ravenous land) not reachable by flood water</td>
<td>Moderate to poor</td>
</tr>
<tr>
<td>Older undulating Surface (T1)</td>
<td>High topography, undulating surfaces devoid of forest comprising mainly silt and clay with minor sand</td>
<td>Poor</td>
</tr>
<tr>
<td>Ravinous land</td>
<td>Comprising mainly silt and clay with intense gulling</td>
<td>Poor</td>
</tr>
<tr>
<td>Sand bar (river sand)</td>
<td>Undulating plain comprising sand silt and clay. Sand is dominant.</td>
<td>Good</td>
</tr>
<tr>
<td>Paleochannel</td>
<td>Channels which are cut off from main course of the river which are buried or abounded comprises of sand, silt and clay</td>
<td>Excellent</td>
</tr>
<tr>
<td>Younger alluvium</td>
<td>Deposited by the rivers maintained and modified every year consisting of clay silt and coarse sand of varying lithology</td>
<td>Very good</td>
</tr>
<tr>
<td>Recent flood plain</td>
<td>Comprising mainly sand, silt and clays characterized by shallow water level.</td>
<td>Good</td>
</tr>
</tbody>
</table>

ACKNOWLEDGEMENT

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REFERENCES

6. Prakash S. Ravi and Misra D., Identification of groundwater prospective zones by using remote


