


# Groundwater potential modelling in Chandraprabha subwatershed, U.P. using Remote Sensing, geoelectrical and GIS

**Amaresh Kr. Singh, S. Raviprakash, D. Mishra and Samarendra Singh**
Remote Sensing Applications Centre, Uttar Pradesh
rsacup@sancharnet.in

**Abstract**
Water plays a vital role in the development of any activity in the area. Thus, the availability of surface and ground water governs the process of planning & development. The surface water resources are inadequate to fulfill the water demand. Productivity through groundwater is quite high as compared to surface water, but groundwater resources have not yet been properly developed through exploration. Keeping this in view, the present study attempts to select suitable locations for groundwater exploration in hard rock areas using an integrated approach of remote sensing, geoelectrical & GIS.

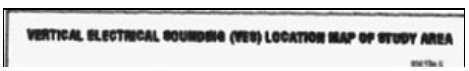
The study area is situated in a part of Sonebhadra, Mirzapur and Chandauli districts of UP, India, bounded by longitudes 83000'39" E & 830 09'28" E and latitudes 24043'15"N & 24051'56" N falling in SOI toposheet no. 63 P/1 & P/2. Geologically the area comprises of upper Vindhyan formations consisting of sandstone, quartzite and shale (CGWB 1985).

Hydrogeomorphological and lineament maps have been prepared using IRS 1B LISS-II data by visual interpretation. Topographic information has been collected from SOI toposheet at 1:50000 scale & TIN has been generated from elevation contour at 20m interval and spot elevation. A slope map has been prepared from TIN. Surface drainage map has also been prepared from SOI toposheet and satellite data on 1:50,000 scale. Hydrogeomorphologically, the entire area comes under BPP-S, BPP-M and DPT category. The drainage pattern is mainly dendritic but locally exhibits structural control.

Vertical electrical soundings (VES) were conducted at 57 sites in the study area for identifying horizontal & vertical variation in subsurface lithology and depth to the hard rock. The geoelectrical data of layer parameters have been correlated with the lithological data obtained from 16 drilled sites in the study area. The study reveals that the aquifer thickness varies between 2 m to 39 m, clay thickness 1 m to 46 m and depth to the hard rock 4 m to 66 m below ground surface. Discharge of drilled sites varies between 135 lpm to 640 lpm. The resistivity of clay, clay kankar varies between 4 ohm-m to 23 ohm-m. Aquifer resistivity ranges from 30 ohm-m to 110 ohm-m. Using the geoelectrical data, clay thickness & aquifer thickness maps have been prepared through GIS technique.

The groundwater potentiality of the area has been assessed through integration of the relevant layers which include hydrogeomorphology, lineament, slope, aquifer thickness and clay thickness, in Arc/Info grid environment. Criteria for GIS analysis have been defined on the basis of groundwater conditions and appropriate weightage has been assigned to each information layer according to relative contribution towards the desired output. The groundwater potential zones map generated through this model was verified with the yield data to ascertain the validity of the model developed. The verification showed that the ground water potential zones demarcated through the model are in agreement with the bore well yield data. Since the present approach was built with logical conditions and reasoning, this approach can be successfully used elsewhere with appropriate modifications. Thus, the above study has clearly demonstrated the capabilities of remote sensing, geoelectrical and GIS technique in demarcation of the different groundwater potential zones.

**Introduction**
The study area covered by hard rock formations,

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facing acute water scarcity problem both for irrigation as well as drinking purposes. Occurrences of groundwater in this type of area is confined in secondary permeable structures i.e. fractured and weathered horizons and in upper unconsolidated materials. The traditional methods of searching sites for drilling of bore hole, have not only had a poor success rate but even the places where such efforts have succeeded, the borewells are known to dried up in a short period of time. The concept of integrated remote sensing and GIS has proved to be an efficient tool in groundwater studies (Saraf, A.K. et.al. 1998, Krishnamurthy et.al 1996 and Murthy 2000). Inclusion of subsurface information inferred from geoelectrical survey can give more realistic picture of groundwater potentiality of an area. Keeping this in view, the present study attempts to delineate suitable locations for groundwater exploration using integrated approach of remote sensing, geoelectrical and GIS techniques.

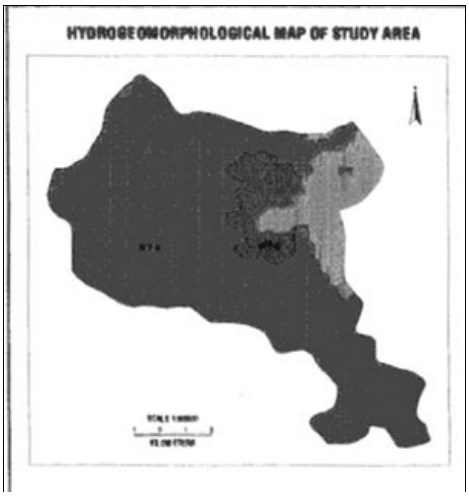

**Study area**

The study area, covered by hard rock formations, is situated in part of Sonebhadra, Mirzapur and Chandauli district of Uttar Pradesh, India bounded by longitudes 83000' 39"E and 83009' 28" E and latitudes 24043'15" N and 24051' 56" N,(fig. 1) covered in Survey of India toposheet no 63P/1 & 63P/2. The total geographical area of watershed is105 sq.km.

**Table - 1**

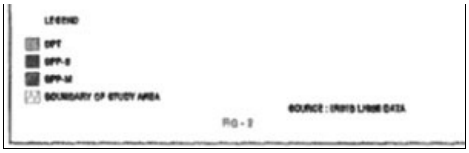
**Weightage of different parameter for groundwater prospects**

| Sl.No. | Criteria | Classes | Weight | |
|---|---|---|---|---|
| 1. | Hydrogeomorphology | BPP-M | 3 | Good |
| | | BPP-S | 2 | Moderate |
| | | DPT | 1 | Poor |
| 2. | Aquifer thickness | > 25 m | 4 | Very Good |
| | | 16 m - 25 m | 3 | Good |
| | | 6 m - 15 m | 2 | Moderate |
| | | <= 5 m | 1 | Poor |
| 3. | Clay thickness (Top impermeable layer) | > 25 m | 4 | Very Good |
| | | 16 m - 25 m | 3 | Good |
| | | 6 m - 15 m | 2 | Moderate |
| | | < = 5 m | 1 | Poor |
| 4. | Slope (degree) | 0 - 0.5 | 4 | Very Good |
| | | 0.6 - 2 | 3 | Good |
| | | 2.1 - 4 | 2 | Moderate |
| | | 4.1 - 9.2 | 1 | Poor |
| 5. | Lineament | Present | 2 | Moderate to Very Good |
| | | Absent | 1 | Poor |




Geologically the area comprises of upper Vindhyan formations consisting of sandstone, quartzite and shale (CGWB, 1985). Vindhyan formation is overlain by quaternary alluvium, which was deposited on the eroded basement. Upper Vindhyan formation represented by kaimur series are divided into two groups, the upper & lower. The lower kaimur consists of quartzite and silicified shales at the base followed by susnai conglomerate, breccia and then quartzite & sandstone. The top of lower kaimur is characterised by thick shales belonging to Vijaigarh shales. The upper kaimur are represented by brown to red, fine grained sandstone followed by white dhandraul quartzite.

Physiographically, the area is mainly flat and gently undulating terrain except few part. The occurrence and movement of groundwater is mainly restricted




within the weathered & fractured sandstone/shale. Groundwater usually occurs in unconfined to confined condition at depth. The area is fed by south-west monsoon rainfall which starts in last week of June and extends until the end of September. The average annual rainfall is about 1065 mm.



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