APPLICATIONS OF REMOTE SENSING AND GEOGRAPHIC INFORMATION SYSTEMS IN GROUND WATER INVESTIGATIONS IN SOHNA BLOCK,GURGAON DISTRICT, HARYANA (INDIA)

B.S. CHAUDHARY°, MANOJ KUMAR+, A.K. ROY* AND D.S. RUHAL°

° Scientists, Haryana State Remote Sensing Application Centre, Hisar, India
+ Research Scholar,School Of Studies In Geology, Vikram University, Ujjain, India
* Head,Geosciences Division, Indian Institute Of Remote Sensing, Dehradun, India

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ABSTRACT

Remote Sensing Techniques play an important role in terrain evaluation surveys for natural/physical resources inventorying and mapping as remotely sensed data provides synoptic view, multispectral and unbiased information with repetivity for change detection studies. The scope has been further enlarged due to advent of Geographic Information System (GIS) and other computer aided methodologies for Digital Image Processing. The present study, a part of Integrated Mission for Sustainable Development project, sponsored by Department of Space, Government of India, deals with ground water investigations in Sohna block. Various thematic maps were prepared by visual interpretation of satellite data, stereoscopic interpretation of panchromatic B/W Aerial photographs and information extracted from digital image processing of satellite data. These were further supplemented with selected ground checks. These maps were digitized and integrated in IDRISI Geographic Environment to prepare final map showing ground water prospective areas. Paleochannels/ channel remnants were found to be excellent for further ground water exploration. Lower reaches of piedmont fan are recommended for further ground water prospection in a controlled manner whereas valley fills are suitable for dugwells/shallow tubewells. Two paleochannels of greater dimensions probably of Yamuna river have been demarcated first time. The study demonstrate the capability of GIS in ground water studies. Sites of wells are recommended to be located on the extension of lineaments or preferably on their extension.

1. INTRODUCTION

Water is one of the most precious natural resources of the earth and it is of utmost importance in every facet of human life. Although water is a more dynamic renewable natural resource, its availability with good quality and proper quantity in appropriate time and space is of significant importance. As a result of population explosion, urbanization and deforestation, there is continuous pressure on this precious gift of nature. Because of over drafting and less recharge, water table is declining at many places, even causing deterioration in quality of water.

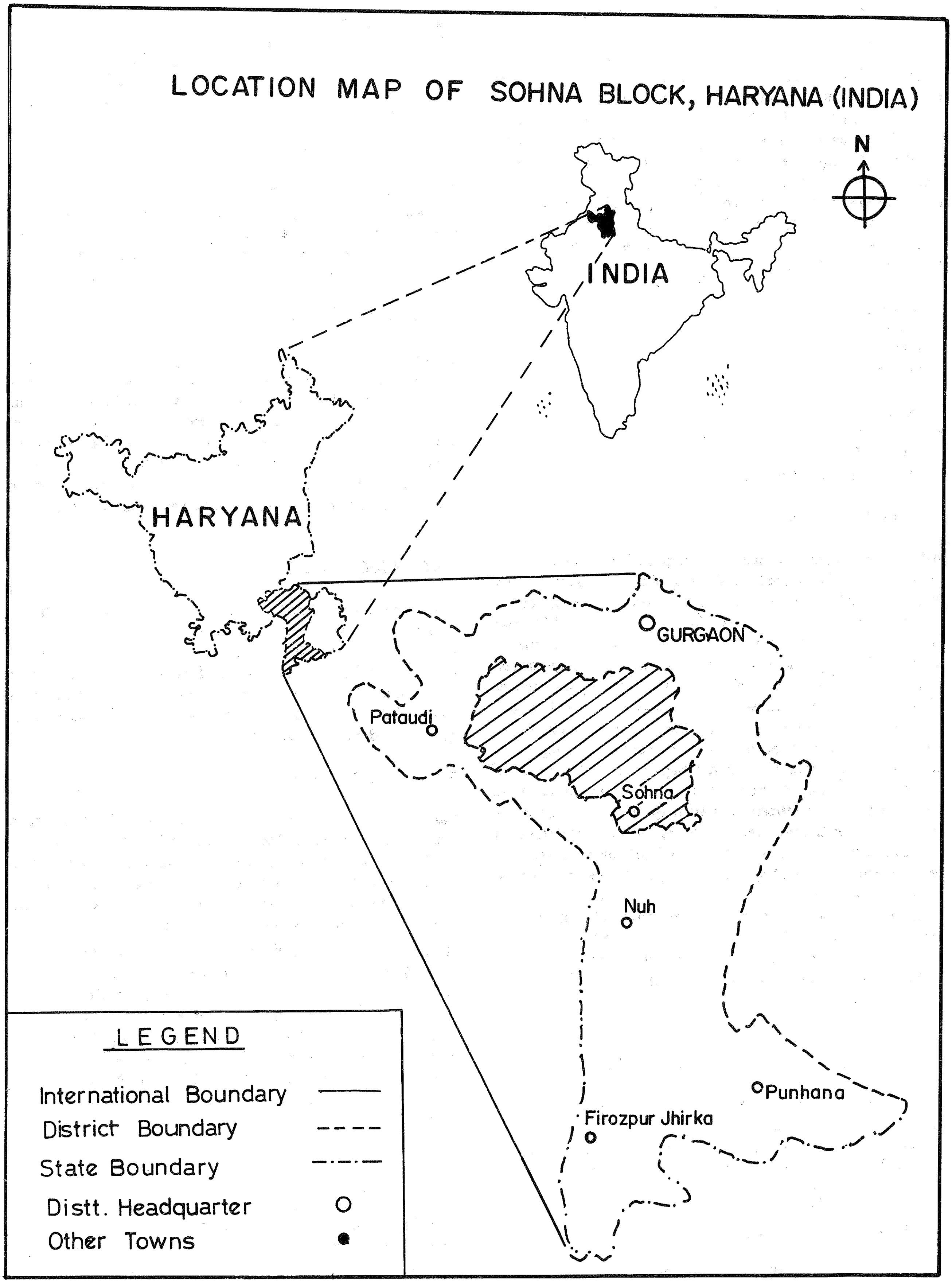
In view of the above facts, delineation of ground water prospective areas has acquired great importance. Advent of satellite Remote Sensing and Geographic Information System (GIS) has added a new dimension in the field of ground water investigations. Although ground water investigations through satellite data and aerial photographs is an indirect approach and complex job, but when it is integrated with field data (e.g. thickness of weathered zone, surface fractures, faults, depth to water level, seasonal water level fluctuations, water quality and tubewell discharge) in a GIS environment, one can get a fairly accurate idea about ground water conditions of the area by preparing "Hydromorphogeological (HMG)" maps (Roy 1993 and Jugran 1995). Therefore, demarcation of ground water prospective zones, using Remote Sensing data and GIS is much more precise and effective. Studies related to remote sensing applications in ground water has also been carried out by many resource scientists in India and abroad (Prakash 1993 and Baz 1996).

2. OBJECTIVES

Objectives of the above study are to prepare geological, geomorphological, hydromorphogeological and other related maps to demarcate the ground water prospective areas and to demonstrate use of GIS in ground water studies.

3. STUDY AREA

The area under study forms southern part of Haryana state which extents from 28°12' to 28°27' North latitudes and 76°51' to 77°15 East longitudes, Covering an area of 480 sq.kms. The location of the area is shown in map - 1. It falls in survey of India toposheet Nos. 53H/3, 53H/4 and 53D/15. Geologically, the Sohna valley has been considered as a major zone of tectonic weakness in the Delhi super group of rocks and is expressed as a longitudinal graben valley extending in North-South direction between Sohna and Harchandpur ridges. The greater part of the area is occupied by the alluvial plain with thick aeolian cover at places, of recent to subrecent age. Widely scattered strike ridges of Aravalli mountain chain of Delhi super group are also seen at places. Geomorphologically the area has been divided into low structural hills, pediment, piedmont aeolian plain, sand mounds/dunes, aeolian plain, piedmont fan and alluvial plain. Sohna is famous for its sulphurised hot spring which is of great medicinal value. This sulphurised hot spring owes its origin to deep seated intersection of faults, one along escarpment face in roughly east-west direction near Sohna whereas another in the east of sohna ridge running roughly in north-south direction.


LOCATION MAP OF SOHNA BLOCK, HARYANA (INDIA)
N
INDIA
HARYANA
GURGAON
Pataudi
Sohna
Nuh
Firozpur Jhirka
Punhana
LEGEND
International Boundary
District Boundary
State Boundary
Distt. Headquarter
Other Towns

MAP No. 1

4. DATABASE AND METHODOLOGY

Digital data IRS 1A LISS II, October 1990, Path 29 Row 48 A1, Geocoded FCC (band 2,3,4) of IRS 1B LISS II, October, 1992 and March, 1993 satellite imagery and panchromatic B/W aerial photographs, 1988 (1:50,000 scale) have been used in the above study. Based on monoscopic interpretation of satellite imagery, by taking into consideration various image interpretation elements such as color, tone, texture, size, shape, shadow and association etc., stereoscopic interpretation of aerial photographs and information extracted from field observations on depth to water level and water quality and digital image processing, the following thematic maps were prepared on 1:50,000 scale.

- Geological map
- Geomorphological map
- Lineament map
- Slope map
- Drainage map
- Drainage density map
- Depth to water level map (Nov. 1994)
- Water level fluctuation map (June to Oct. 1993)
- EC based quality map

All the above thematic maps were digitized by reducing these maps on 1:131,578 scale to fit the size of the digitizer (20 cm x 20 cm). IDRISI GIS software package was used to integrate all the above thematic maps. A standard grid cell size of 200X200 has been selected by considering a number of factors like size of minimum interpretable unit and appropriate format for the screen display. All these digitized maps were rasterized by the process of lineras and polyras. A rating weightage factor system has been developed for the integration of these thematic maps. A numerical rating system ranging between 0 to 10 have been assigned to various classes of individual theme maps based on the degree of influence of individual categories on ground water regime of the region. Secondaly all these thematic maps have been assigned a weightage factor, this is called equal wieghtage integration method aimed at reducing subjectivity in the analysis, however it can not remove subjectivity in rating/coding, completely from the analysis. Two composite maps one based on integration of satellite based information and another integrated field observation map, were prepared. These were further overlayed and a composite map was prepared. By integrating this map with EC based quality map, hydromorphogeological map was finally prepared showing utility map for ground water prospects.

5. RESULTS AND DISCUSSION

Hydromorphogeological map of the area is shown in map -2. Utility map showing ground water prospects in various zones is shown in map -3. Hydromorphogeological characteristics and ground water prospects of various geomorphic units are discussed below:

5.1 HILLS

5.11 Low structural hills: The area is traversed by two parallel ridges bordering the N-S Sohna valley, known as Harchandpur and Sohna ranges. These are composed of Alwar group of rock formations of Delhi super group. Lithological composition is essentially quartzites with pegmatite veins and schist intercalations with subordinate bands of arsenopyrite and graphite. Five set of joints have been demarcated. In the vicinity of pegmatite bodies the quartzites are often sheared. Joints allow limited infiltration into them. However by and large "low structural hills" acts as a zone of surface run off and is negligible from ground water point of view.

5.12 Valley fills: It consists of unconsolidated material, coarse to fine sand, silt and clay. Water level was observed as 6 to 12 meters below ground level (bgl) with fresh quality. It is good from ground water prospects point of view. It harbours limited water hence dug wells/ shallow tubewells are suggested in this zone.

5.2 PEDIMENT

A narrow zone immediately bordering the hills is pediment, representing partly an undulating rocky surface sloping away from the hills and partly a surface with very shallow weathering and a thin veneer of soil. It is composed of weathered quartzites with gravelly soil and is found at few places in the study area. Water level in this zone varies from 15 to 20 metres (bgl). Pediments with joints or fractures yield limited extent of ground water. This zone is poor from ground water exploration point of view.

5.3 PIEDMONT PLAIN

This zone is constituted of both piedmont aeolian plain and piedmont alluvial fan plain. It is composed of coarse to fine sand, silt and clay and is highly porous and permeable. Dendritic drainage pattern observed. This is a fresh water zone with water level ranging from 16 to 21 metres (bgl). EC in this zone varies from 0-2,000 micromhos/cms. It falls under fairly moderate to good ground water prospective zone.

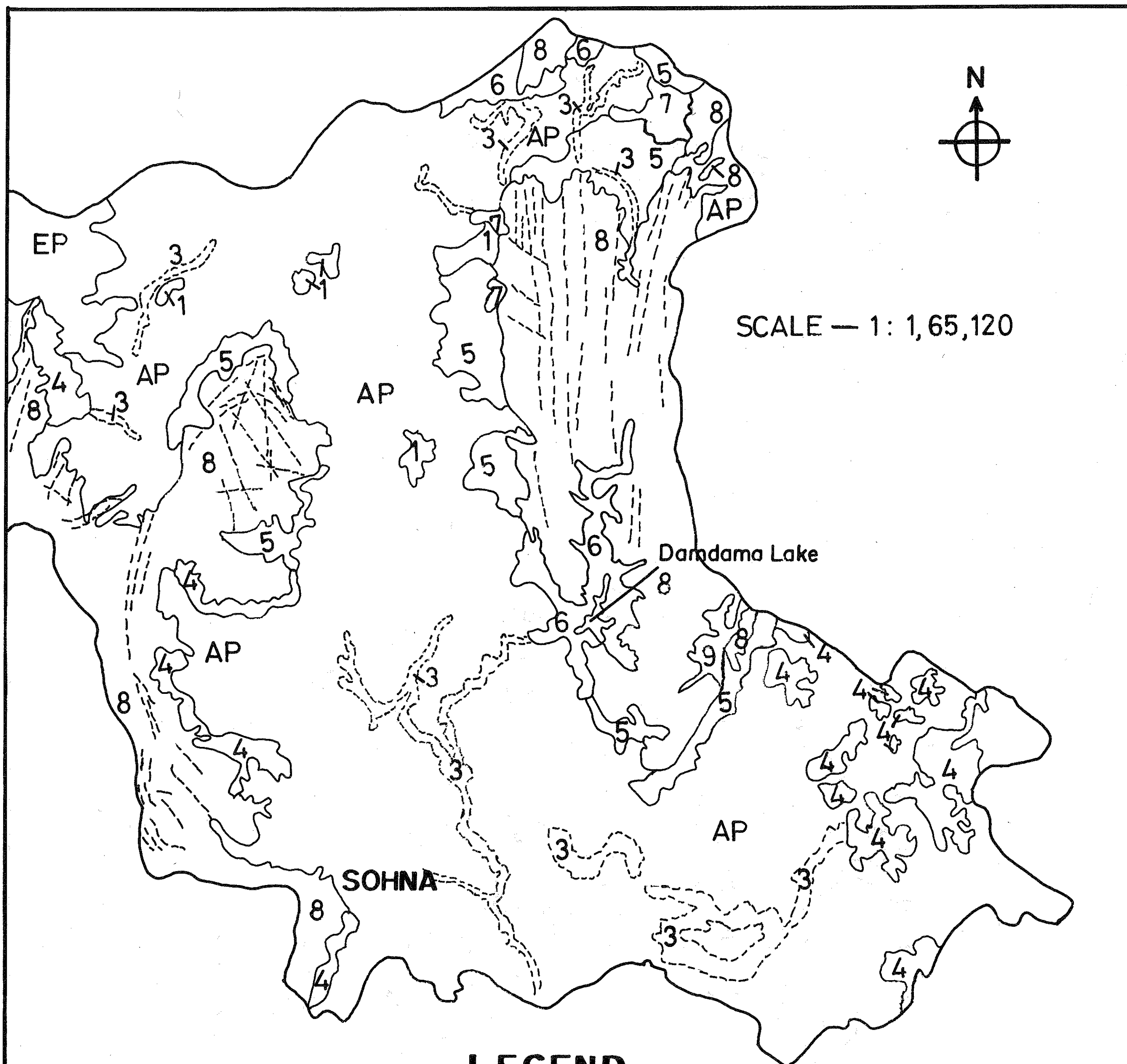
5.4 AEOLIAN PLAINS

Large area in western side is covered by sand of aeolian origin with presence of scattered sand dunes/sand mounds. The color of sand varies from light brown to tan/buff. Lithological composition is medium to fine sand with little clay. It is porous and permeable. There is no surface drainage in this zone, but small drains which originate from hill sides die out in this area, hence it is good from ground water recharge point of view. Depth to water level varies from 17 to 27 meters. EC in this geomorphic unit varies from 0-2000 micromhos/cms. Average discharge of tubewells in this unit ranges from 150 to 350 ltrs per minute (lpm). This is good to moderate from ground water point of view. Moderately deep to deep tubewells are recommended in this area. Artificial recharge should be considered by constructing check dams/water harvesting structures or erthen dams at suitable locations after due investigations.

5.5 ALLUVIAL PLAIN

5.51 Paleochannels/channel remnants: Two paleochannels of probably Yamuna River have been demarcated in the area. Few channel remnants have also been identified. These are composed of coarse to medium sand with silt and clay, forming good aquifers. These are highly porous with water level varying from 4-9 meters (bgl). Shallow to deep tubewells are feasible. This unit is excellent from ground water point of view. Pump test results show tubewell discharge of 632 lpm near village Isaqi in this unit.

HYDROMORPHOGEOLOGICAL MAP

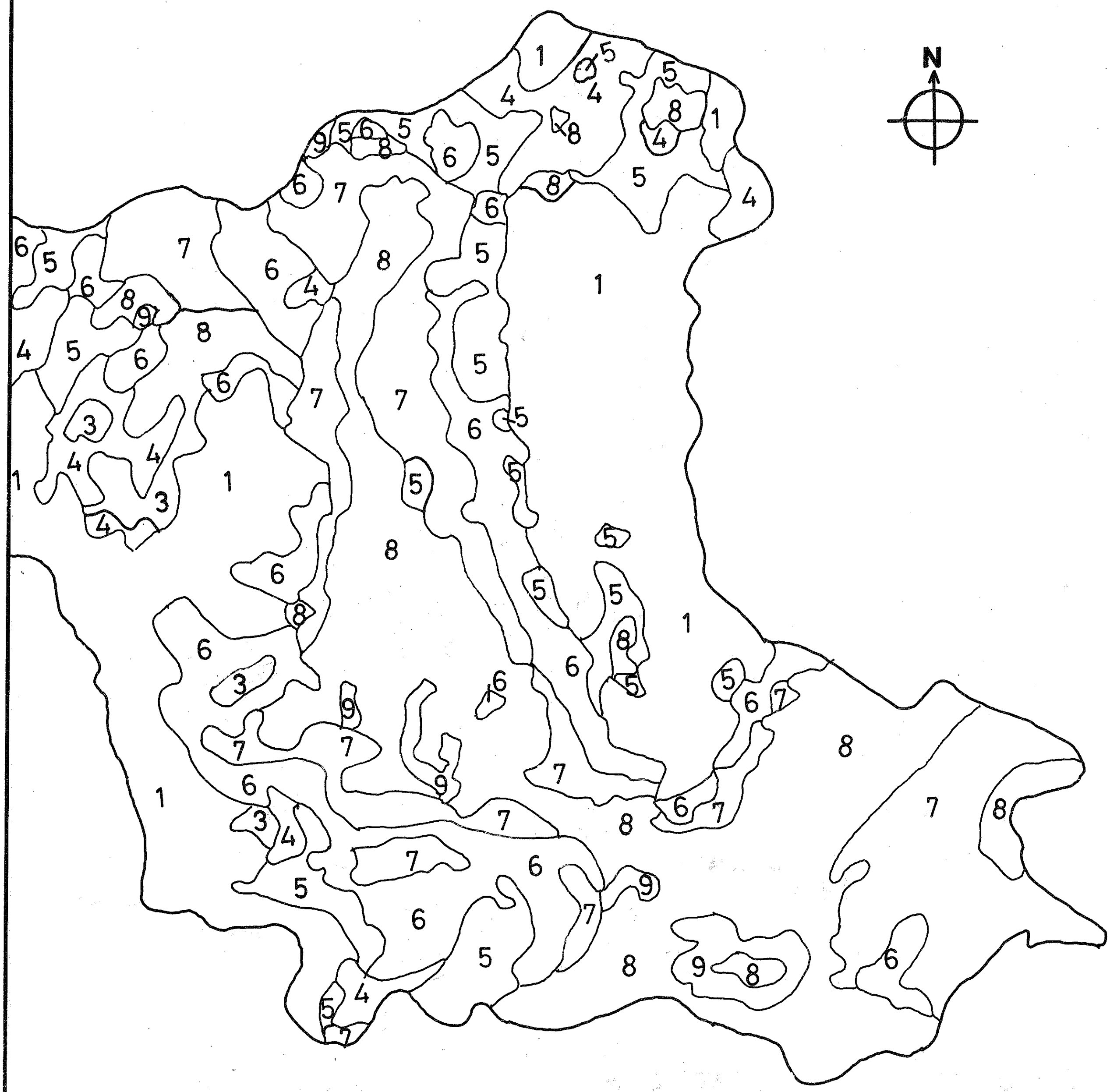


LEGEND

GEOMORPHIC UNIT	LAND FORM	GROUND WATER PROSPECTS	MAP SYMBOL
AEOLIAN PLAIN (EP)	Sand mounds	Poor to Moderate	1
	Sand sheet	Moderate	2
ALLUVIAL PLAIN (AP)	Paleochannel / Channel remanants	Excellent	3
	Depression area / Water logged	Very good to good	4
PIEDMONT	Piedmont alluvial fan / Plains	Good	5
	Piedmont aeolian plains	Moderate	6.
PEDIMENT	Dissected pediment	Poor	7
HILLS	Dissected hills (Cuesta hogbag)	Nil	8
	Valley fills	Good	9

MAP No. 2

UTILITY MAP OF SOHNA BLOCK, HARYANA



MAP No. 3 Enlarged from GIS photographic result.

GROUND WATER PROSPECTS

1, 2, 3	POOR TO VERY POOR
4, 5	MODERATE
6, 7	GOOD
8, 9	VERY GOOD TO EXCELLENT

5.52 Older alluvial plain/low lying depressional areas: Seasonal inundation/water logging is the problem in low lying depressional areas. It is composed of silt, fine to coarse sand and clay. A layer of lime nodules (kankars) was observed in this unit at a depth of 6 to 9 meters. Kankar-clay and sand and kankar, form good aquifers. Ground water movement stagnation was observed at places creating local ground water quality problems. EC in such areas varies from 4000 to 6000 micromhos/cms. Water level varies from 4 to 15 meeters. Except these low lying depressional areas, this zone is very good from ground water point of view.

6. CONCLUSIONS

From the above study it is concluded that remote sensing and GIS can be effectively utilized for delineating ground water prospective areas. Various ground water worthy features can be easily picked up from the satellite imagery and aerial photographs. Further ground water prospection is recommended along paleochannels/ channel remnants in a controlled manner, whereas valley fills are suitable for dug wells/shallow tubewells. Sites of the tubewells should be so chosen that they should fall on the extension of lineaments or preferably on their inter section. Proper drainage network should be provided in low lying depressional areas to avoid quality problem.

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