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Mapping of lineaments and knowledge base preparation using Remote Sensing and GIS techniques of the Morna River Basin, Akola District, Maharashtra, India

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ABSTRACT

Earth consists of hard rock layers where water is restricted to secondary permeability, and thus to fractures and the weather zones. Structural geology studies, geologic lineaments and their pattern information are essential for better planning and execution of projects to avoid any natural hazards. Satellite images, aerial photographs and digital elevation models will give lineament information. Recent advances in digital image processing allow such lineament extraction to be accomplished in semi-automatic to fully automatic approaches. The accuracy of extracting lineaments depends strongly on the spatial resolution of the imagery, higher resolution imagery result in a higher quality of lineament map. In this paper, an attempt has been made for Mapping of lineaments and knowledge base preparation using remote sensing and GIS techniques for part of the Morna River Basins, India.A methodology for lineament extraction and the design of a knowledge-based lineament identification system has been proposed for geological aspects of any developmental activity. This methodology might potentially be adopted for the identification of several features of geological or anthropogenic origin.The study results of the extracted lineaments can be applied to structural geology studies and their applications such as Soil and Water conservations, facility sittings and water resource investigations, groundwater studies and also for finding suitable sites for dams, and reservoirs.

Keywords: - GIS; Remote Sensing; GPS; Liniment Mapping

Introduction

Generally, hard rock areas are always prone to frequent water crisis, it is important to understand hydro-geomorphological nature of landforms and lineament distribution with respect to the permeable nature of subsurface, percolation, runoff status of the region. Lineament study of the area from remotely sensed data provides important information on sub-surface fractures that may control the movement and storage of groundwater. In recent years extensive use of satellite remote sensing has made it easier to define the spatial distribution of different groundwater potential zones based on the geomorphology and it's associated features (Sankar, 2002). Satellite Remote Sensing techniques are also extremely useful techniques for groundwater exploration, especially for delineating hydrogeomorphological units (Baldev et al, 1991; Krishnamurthy, 1993; Krishnamurthy and Srinivas, 1995). Satellite image from Landsat 7 ETM has been analyzed for lineaments (Lattman, 1958; O'Leary et al, 1976), hydro-geomorphological studies (Tiwari and Rai, 1996), land use and land cover mapping (Anderson et al, 1976) and for groundwater development works. Lineaments can play a major role in identifying suitable sites for artificial recharge ofgroundwater because they reflect rock structures through which water can percolate andtravel up to several kilometres (Krishnamurthy et al, 2000).Lineaments seen on remote sensing data like satellite image/aerial photographs and geophysical data etc. are of great relevance to geoscientists as they reflect various structural feature of an area.Mapping and analysis of

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lineaments help in understanding the structural and tectonic set-up of an area. Lineaments, which represent faults, fractures, shear zones, joints, litho-contacts, dykes etc. Can be mapped easily using remote sensing data. Mapping and analysis of lineament are only help in understanding the structural/tectonic aspect of an area but also in turn are useful in exploration of mineral, ground water, oil and in understanding the seismicity of a given area

Study Area

The Morna River basin which is a tributary of PurnaRiver lies towards the northern and southern part of Akoladistrict, and parts of Washim district, forming near about190 to 200 meters thick lava flows covering an area of941.39 sq. km. and lies between 76o45'38" to 77o 5' 26" Elongitude and 20o 25' 7" to 20o 29' 34" N Latitude andSurvey of India Toposheets No. 55H/1,H/2, H/15, D/3, and55D/15(Fig 1).

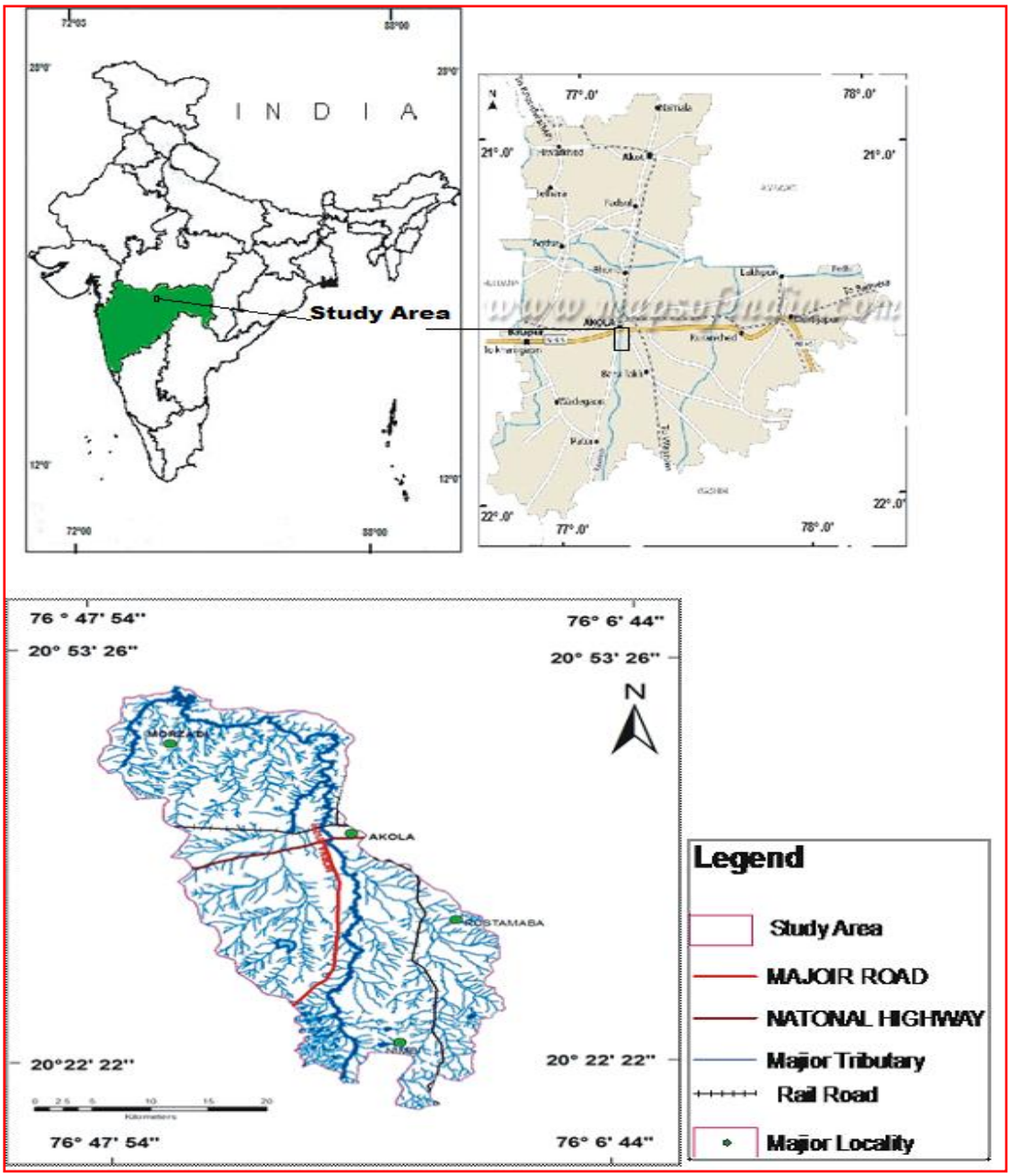

Fig.1: Location map of the Morna River basin.

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Methodology

In order to delineate hydro-geomorphological and lineament maps, the geo-coded 1:5000 scale LISS-III satellite imagery was used. Basic image characteristics like tone, texture, shape, colour, associations, etc were used, along with field parameters such as topography, relief, slope factor, surface cover, soil and vegetation cover were considered while delineating hydrogeomorphic and lineament maps. From lineament map, other maps such as lineament density and lineament intersection maps are prepared. Then suitable logical weights are assigned to each unit of thematic maps and integrated in GIS using the spatial overlap method to delineate groundwater potential zones.

Geology of the Area

The northern part of the Morna basin is characterized by presence of alluvial deposit and southern part is covered by Deccan trap ,the alluvium deposit belongs to quaternary age and can be broadly divided into older and younger alluvium and it shows graded pattern, the older clay silt and coarse sand grading upward into fine sand silt and clay and unconformably overlies the basaltic lava flows, whereas the younger alluvium consists of fine sand silt and clay deposits with few lenses of pebble beds in between. The alluvial deposits in the area are basically derived from the disintegration and decomposition of the basaltic rocks and are classified into two broad groups

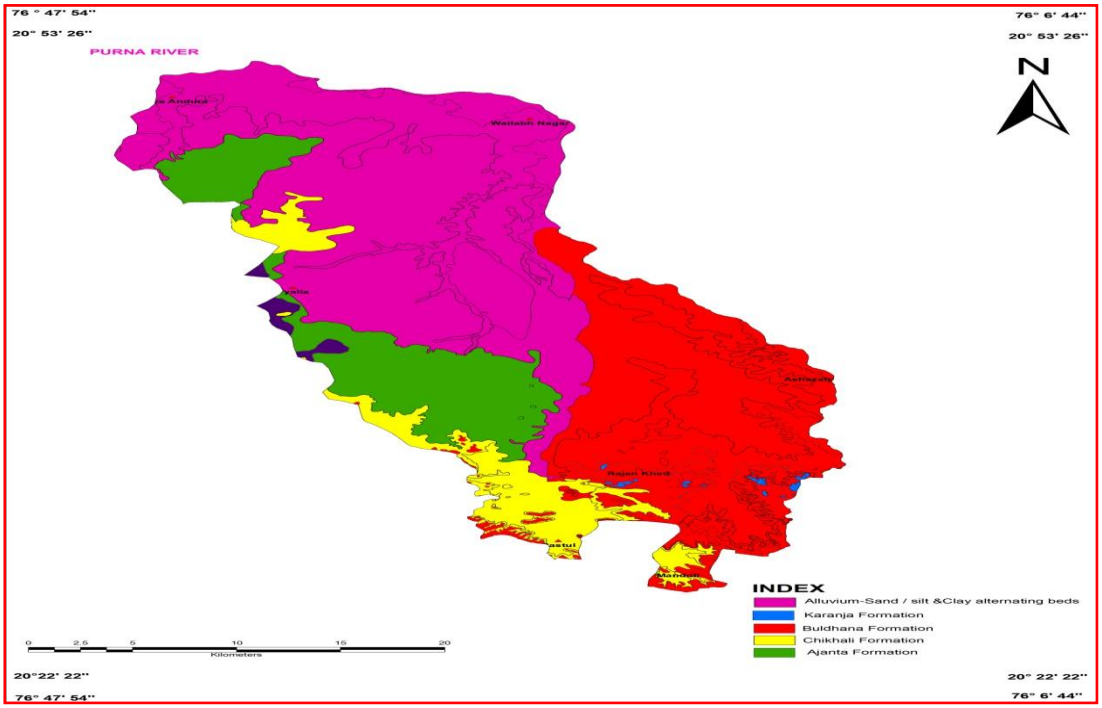

Fig. 2 Geological map of the Morna River Basin showing different formations.

Hydro geomorphology

The area under investigation is traversed by Morna river basin experiencing sub-tropical or tropical monsoon climate. The area is characterized by undulating relief with the presence of alluvial horizon towards the northern part and massive to highly altered basalt towards southern part of the basin. The area is characterized by the presence of heterogeneity within the rock formation which in turn affects groundwater recharge. On the basis of major geomorphic processes and agent involved in the

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study area. The landforms can be grouped in to structural, denudetional and fluvial origin. The occurrence of groundwater in lava flow is prominent in highly altered fractured, jointed horizon which serves as a potential flow zones for the accumulation of the groundwater. Where as in vesicular formations groundwater occurs in interconnected vesicles both under water table and confined conditions .The dug wells in a few trappean terrains located in favourable hydrogeological sites have yields of the order of 100-125 m^3/day However, in general the study area is characterized by lowest permeability range (6-8m/day).

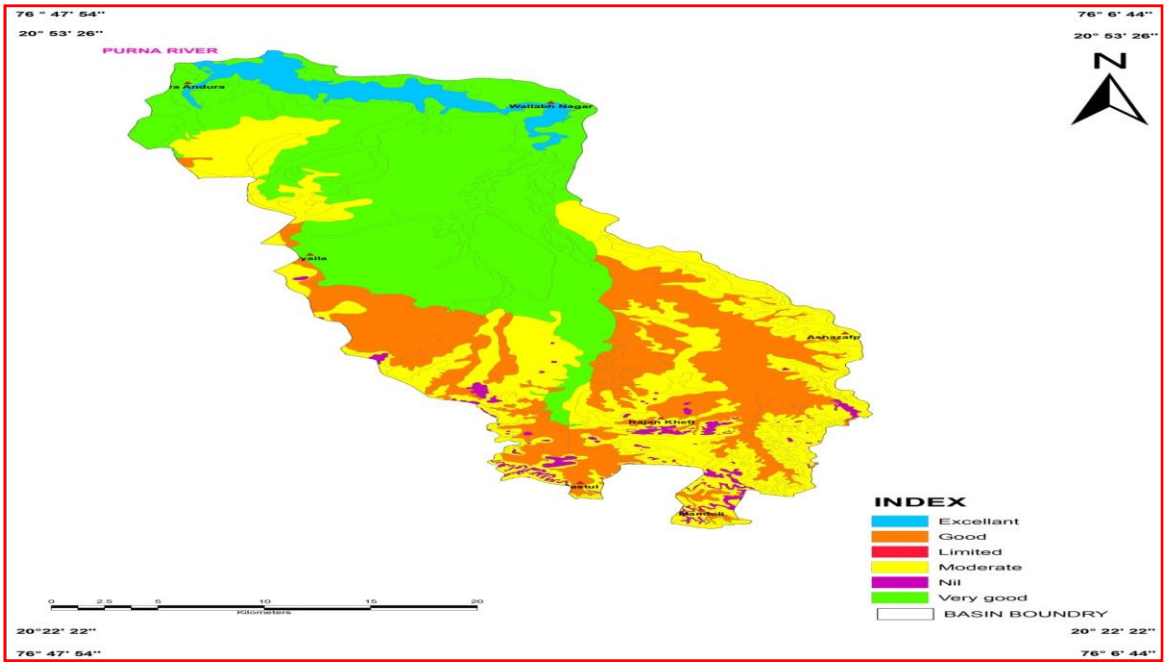

Fig. 3Hydro-geomorphology map of the Morna River basin.

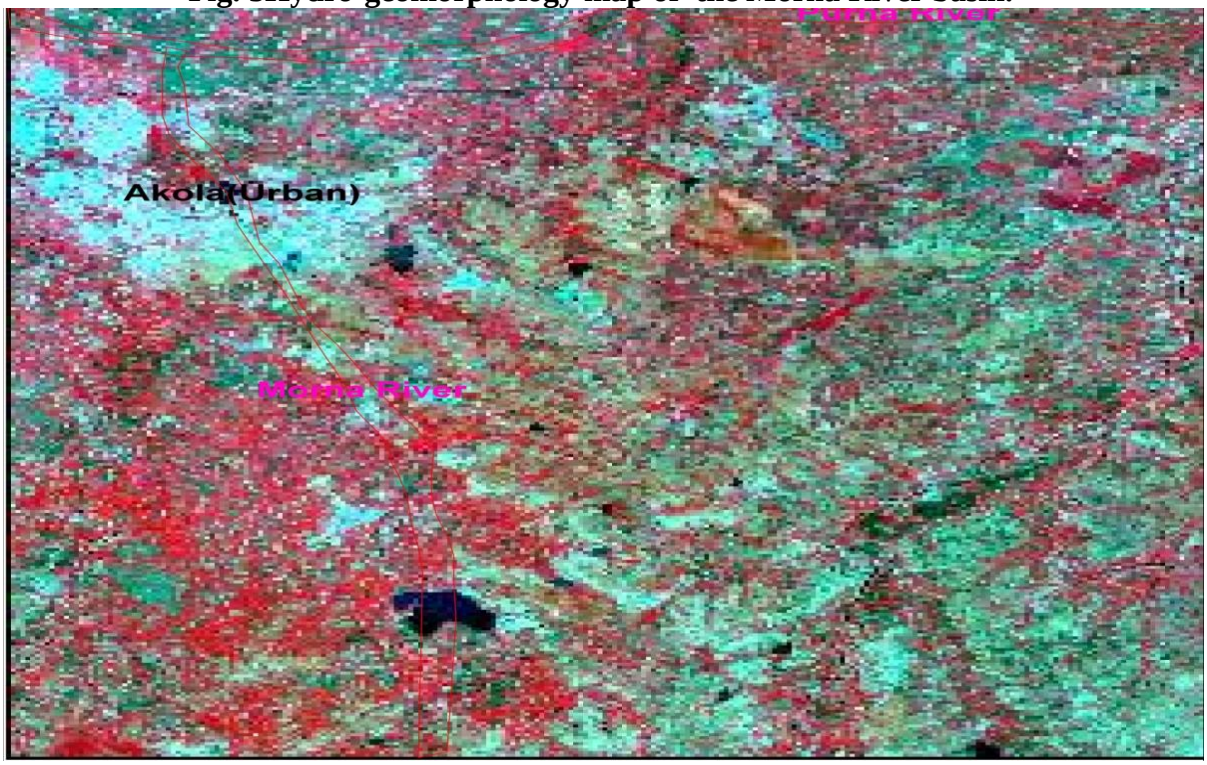

Fig.4: Satellite image of the Morna River basin.

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Lineament Pattern

Lineaments have been identified on images through visual interpretation (Fig.5) by comparing spatial variation in tone, colour, texture, association, etc. 25 m area on either side of lineaments and intersections of lineaments are considered to be favourable for accumulation of groundwater. Lineament study (Fig.5) of the area from remotely sensed data provides important information on sub-surface fractures that may control the movement and storage of ground water. Sub-surface permeability is a function of fracture density of rocks. Numerous lineaments have been identified and marked in the area. They are having varying dimensions and areal extents as well. Lineaments are nothing but the manifestation of linear features that are identified from remote sensing data. These linear features usually represent faults, fractures or shear zones and are identified on satellite images on the basis of tonal contrast, stream or river alignment, and differences in vegetation and knick-points in topography. The concentrations of lineaments are more in southern central region of the study area than the northern regionTherefore, the density of lineaments increases towards the lower reach of Morna River basin than the upper reach as well as and generally having east-west trend. A close observations of the lineaments interpreted from IRS imagery revealed the presences of two generations of lineaments. For instance, the satellite imagery data interpretations supports the view that Gavilgarh faults indicates an older age and the remaining lineaments represents an younger age. The basin lies between two major lineaments i.e. Purna lineament following the course of Purna River display a WNW-ESE trend it is traceable for over 200 km from south of amrvati in the east to some distance east of Jalgaon in the west,where it merges into Tapi lineament, this lineament lies in the northern part of the basin and the southern part is delineated by Kaddam lineament trending NW-SE and extends upto 280 km and that has been named after Kaddam River whose course has been controlled by this fault lineament. This lineament has northerly dip. Faulting has been recognized in several sectors of this lineament.The basin lies between two majorlineaments i.e. Purna lineament following the course of Purna River display.

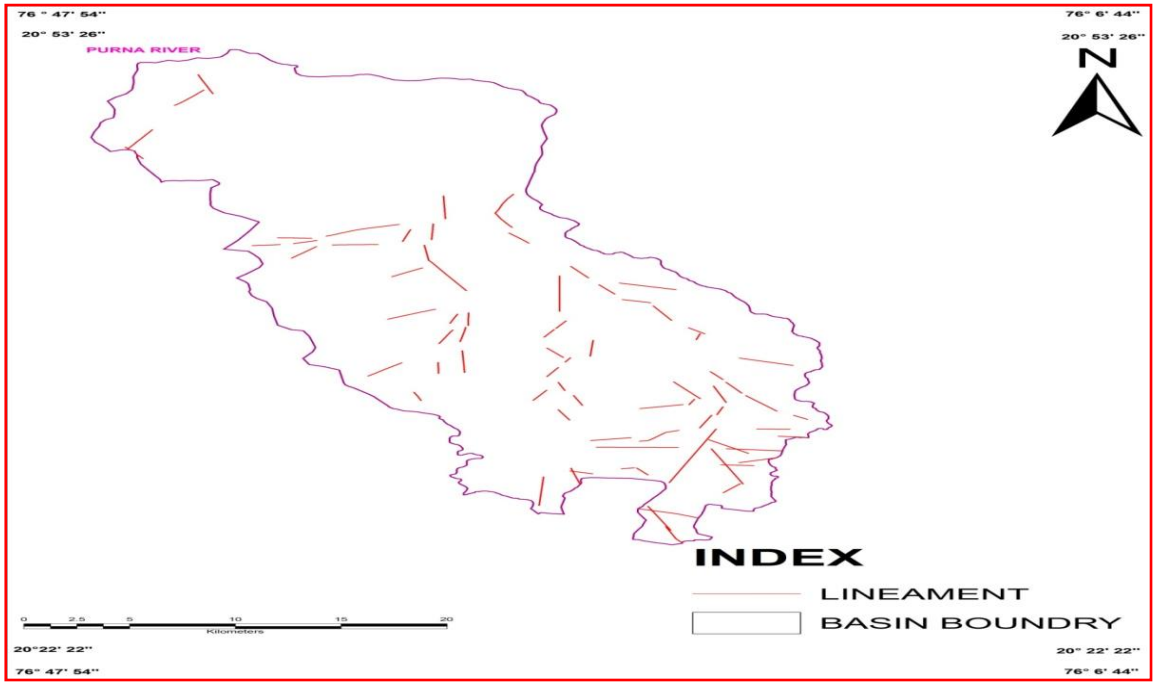

Fig.5 Lineament pattern map of Morna River basin

Conclusions

The Hydrogeomorphological analysis of a watershed is a very simple tool, which covers the modern techniques of remote sensing and GIS. This technique coupled with geological data can certainly be used in in evaluating the parameter pertaining to groundwater and accurate zoning of ground water potential of a region. Lineaments, particularly joints/fractures and their intersection appear to be potential sites for groundwater exploitation. In the present study area, the valley fills, pediplains and buried pediments are appearing to have good groundwater potential. Remote sensing techniques with an emphasis on geology, geomorphology, physiography, hydro geomorphology, structure, geo-hydrology, land use/land cover help in identification of the potential zones for developmental planning and predicting limitations to their implementation with reasonable accuracy. The present information, if depicted in the form of a prospect map along with thematic layers and the use of GIS for the ultimate data integration based on the user defined criteria with weighted approach, would provide first-hand information to local authorities and planners to identify possible potential sites for groundwater exploration.

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