REMOTE SENSING AND HYDRO-GEOMORPHOLOGICAL STUDIES TO EVALUATE GROUNDWATER POTENTIAL ZONES OF DAKSHINAPINAKINI RIVER BASIN, CHIKKABALLAPURA AND BANGALORE DISTRICTS, KARNATAKA

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Abstract

The present study is carried out at Dakshinapinakini river basin, Chikkaballapura and Bangalore districts with reference to remote sensing and hydro-geomorphology to evaluate the potential zones of groundwater occurrence. Geologically the area falls in the semi arid region of older Peninsular Gneisses and associated with ancient Supra-Crustal rocks giving an age ranging from 3000 to 3400 m.y. Hydro-geomorphically the area is divided into five geomorphic features such as Residual hills, Pediments, Pediplain, Valley fill and Lateritic uplands. The groundwater occurrence is good in valley fill areas and in the pediplains, it is moderate to good. The residual hills and pediments have poor to moderate groundwater potentiality.

Keywords: *Remote Sensing, Hydro-geomorphology, Dakshinapinakini River basin, Residual hills, Pediments, Pediplain, Valley fill and Lateritic uplands.*

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1. INTRODUCTION

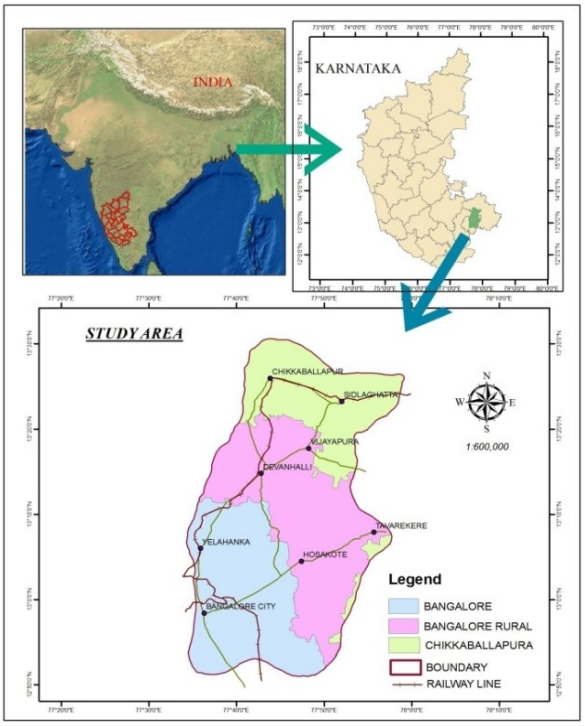
The increasing population has been creating more and more stress on water for drinking and agriculture sector for increasing food grain production, which consequently increased deforestation and the demand for more and more water. The available surface water resources are inadequate to meet the entire water requirement for various purposes. So the demand for groundwater has increased over the years. Generally, groundwater is less prone to pollution in comparison to surface water. Hence groundwater serves as an important source of water for various purposes in rural and urban areas.

Hydro-geomorphology is defined as the study of landforms caused due to the action water (12]. To find out potential zones of groundwater occurrence the integration of geo-morphological, lithological and structural data is very much important. In the present field investigation study, an attempt has been made to evaluate the groundwater occurrences in the Dakshinapinakini river basin.

Intensive use of Satellite remote sensing in recent years has made it easier to define the spatial distribution of different groundwater prospect classes on the basis of geomorphology and other associated structural features [1,4]. In the earlier studies remote sensing techniques have been applied for groundwater prospecting effectively in several areas [3,5,6,7,11,13].

2. STUDY AREA

Dakshinapinakini river basin is a sub-basin of river Kaveri, rises in Nandi hills of Chikkaballapura district, flowing



Map-1: Location map of the study basin.

towards NW to SE direction over a length of 68.75 km, covering an area of 2185 sq.kms in parts of Chikkaballapura, Kolar and Bangalore rural and urban districts of Karnataka (Map-1). The area belongs to old peninsular gneissic terrain, bounded by latitude 12^0 15' to 13^0 32' N and longitude 77^0 34' 30'' to 78^0 00' E. The study area is covered under the semiarid and subtropical climate characterised by medium to hot weather and normal average annual rainfall of 775.39 mm. The area is an undulating terrain and the highest elevation is 1466 m and a minimum elevation of 903m.

3. METHODOLOGY

An attempt has been made in the present study to evaluate the groundwater occurrences in the study area by using Geographic Information System and Satellite remote sensing data. Different types thematic maps viz., geo-morphology, land use/land cover, slope and lineament maps have been prepared through the standard visual interpretation techniques using topographic maps with its corresponding Indian Remote Sensing 1C and 1D geo-coded satellite data. Ground information /data generally constitute an important database in remote sensing techniques, because they increase the interpretation accuracy to a large extent. Survey of India Topographical maps on 1:250000 scales have been used in the preparation of base map. The imagery was visually interpreted by using standard keys such as drainage pattern, shape, colour, tone, texture and topography etc., to prepare the geo-morphological map. The essential information such as hydrological, geological and other data collected during the field visits were used for the finalization of the hydro-geomorphological map (Map-3). Arc GIS (3.2a) software has been used for digitization, computation and output generation purposes. The flowchart of the methodology followed in the present is shown in Figure.1.

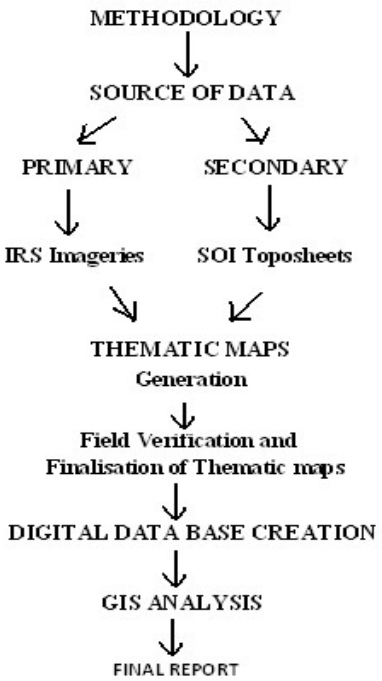


Fig: 1 Flow Chart of Methodology.

The essential morphometric parameters of the area has been determined to derive the general geomorphic characteristics of different landforms. Groundwater occurrence in the different geo-morphological units viz. Residual hills, Pediments, Pediplain, Valley fill and Lateritic uplands are discussed.

4. RESULTS AND DISCUSSION

4.1 Geology of the Area

The study area has undulating terrain and is composed of peninsular gneisses, pink/grey granites, lateritic hills and some basic dykes. The general trend of peninsular gneisses are NNW-SSE and NW-SE direction. They are highly migmatitic in nature. The granites occur as intrusive in the gneissic rocks and are varying in colour, texture and structures. The area is traversed by different sets of basic and acidic intrusions. The rocks are highly jointed and sheet jointing parallel to the exposed surface are favorable for occurrence and movement of groundwater.

4.2 Drainage Pattern

The study basin exhibits dendritic pattern of drainage (Map-2), which is typically of massive hard crystalline rocks. The basin is 6^{th} order of drainage network. Bifurcation ratio is 4.1, which is normal according to Horton and it indicates the basin is at mature stage of development.The length of river basin is 68.75 kms.The drainage density is 1.10 km/km^2 and it indicates coarse texture and also classed as a good catchment area.The hypsometric integral is 24%. This indicates that the basin has already crossed maturity stage and it is in the early monadock stage with the presence of resistant rock bodies and is less susceptible to erosion.

4.3 Hydrogeology

The study area is comprised of crystalline, hard and massive rocks and are devoid of primary porosity, but the joints, fractures and fissures act as reservoir and conduits for groundwater percolation. The contact zones between gneiss and granite, granitic gneiss and laterites have proved to be more successful for groundwater occurrences in the study basin. Groundwater occurs in the unconfined condition in the weathered pegmatitic veins Also in the jointed and fractured zones groundwater will be present. The weathered granitic layers and fractured layers are two distinct aquifers and no connection exits with each other [2,10]. Groundwater movement is controlled by lineaments, dykes and quartz veins. The lineaments serves as conduits for movement of groundwater, where as dykes and quartz veins obstruct movement of groundwater. The yield of wells in the study basin depends on intensity of weathering and spacing of primary joints. The depth to bedrock ranges from 20 to 30 m. in granitic and gneissic terrain, 60 to 20 m in lateritic areas.

Map-2: Drainage map of the study basin.

The average thickness of alluvium along the river channels is 20 meters in the upper and 60 meters in the lower reaches of the stream.The average depth of weathering in recharge areas is 10 to 12 m. whereas in discharge areas varies from 15 to 20m. The weathered, fractured portions of the hard rock and the alluvial deposits constitute the main repository for groundwater. Groundwater occurs under confined to semi-confined conditions. The sheet fractures and foliations in granites and other pore spaces in laterites at shallow depths are very promising zones. It is observed that granitic rocks have better fracture system and are favorable to hold considerable groundwater than other rocks.

5. HYDRO-GEOMORPHOLOGICAL CHARACTERISTICS OF THE STUDY AREA

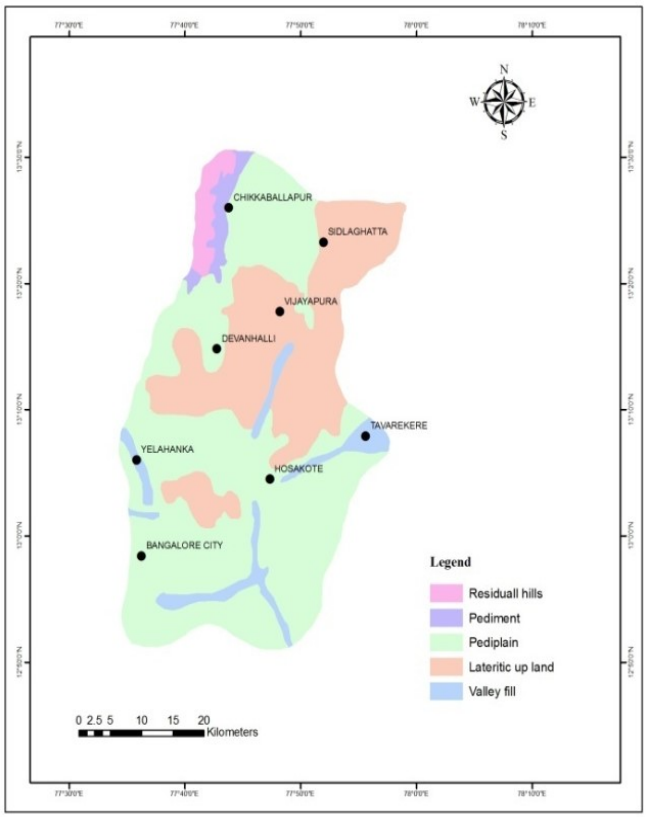
The identification and mapping of the various landforms are very essential for evaluating groundwater potential and prospects of landforms exercise a significant control over the groundwater potential of an area (Map-3). In view of the importance of groundwater exploration activities, detailed map showing different landform units have been prepared from the interpretation of satellite imagery. The area is an erosional landscape with undulating and rolling topography. On the basis of the specific relief and characteristic nature, landforms present in the study basin are classified into the following types:

5.1 Residual Hill (Rh):

Residual hills are formed due to various sizes and heights, occurring and erosional remnants rising over the pediments and pediplain surfaces are included in this unit. These are mainly composed of granites and peninsular gneisses. These are found in the northwestern part of the study area, which act as runoff zone and contribute significant recharge to the nearby valleys.

5.2 Pediment (Pd):

Pediments are undulating bedrock surfaces of limited extent occurring at the transition between hills and plains covered with detritus. These are noticed in the north and at certain parts in the southern region of the study area. Generally pediment act as runoff and recharge zones when traversed by fractures. The groundwater prospects are poor to moderate in this zone.



Map -3: Hydrogeomorphological map of the study basin.

5.3 Pediplain (Pp):

Pediplain is a gently undulating plain with weathered mantle of varying thickness of overburden with different soil cover. The overall slope of these plains being very low, even the inter sub-basin areas have been observed to be consisting of weathered mantle of significant thickness at places, forming shallow aquifers. The groundwater potential is moderate to good depending upon the fractures, fracture valleys and structurally controlled zones. The contact zones of the pediplains/pediments of different rock types are observed to have good groundwater potential.

5.4 Valley Fills (Vf):

The valley fill deposits found in central, south and eastern part of the study basin. The valleys of different sizes and shapes occupied by valley fill material. They have been classified based on the thickness of valley fill. These units form moderately productive shallow aquifers, subjected to the materials, composition and recharge condition. The groundwater potential is moderate to good along lineaments and in valley fills with fractures is found to be very good.

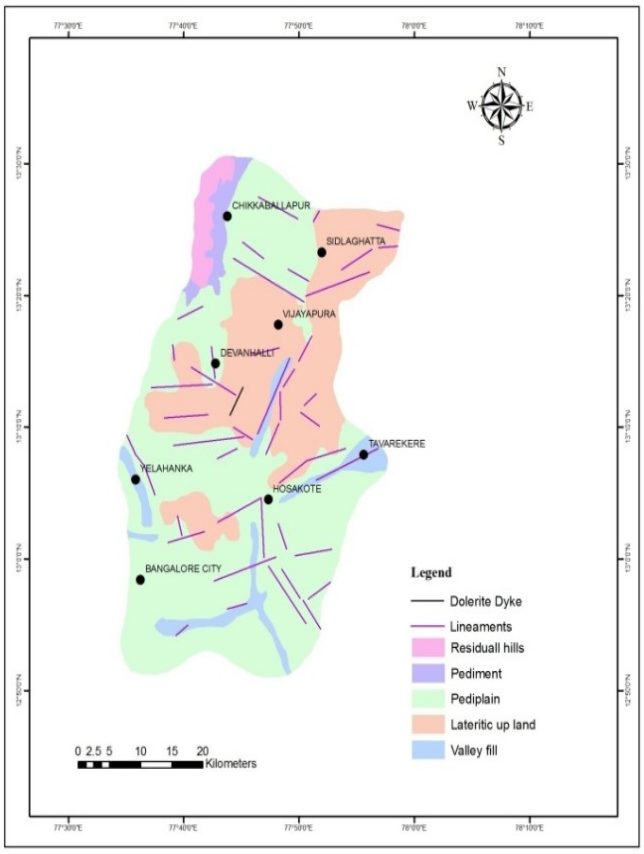
5.5 Lateritic Upland (Lu):

Elevated zones occupied by lateritic material in parts of north-east and central parts of the study basin have been identified as lateritic upland. Groundwater potential in these zones is found to be poor to moderate. However, in areas of favorable hydro-geological setup of ground water potential is found to be good.

6. LINEAMENTS

A lineament is defined as large linear structural feature, which describes itself in terms of topography and underlined by other structural features. Such features may include ridges and hill ranges or narrow straight mountain and valleys controlled by jointing or faulting, straight drainage lines, lines of isolated hills, straight coastlines and boundary lines of different rock formations or lines of outcrops [8]. The lineaments in the study area have two prominent directions. One set is almost in NW-SE direction and other set is in NNE-SSW direction. There are few lineaments trending perpendicular to the later set of lineaments. The flow of trunk channel segment of the sub-basin follows a zone of strongly controlled by lineaments present in the area, especially in certain parts in the southern region of the study area.

Based on the hydro-geological and hydro-geomorhological studies through the visual interpretations, a groundwater prospective zone maps have been prepared and are classified into three regions viz., high, low and medium groundwater potential zones. The less potential groundwater occurring zones are found in the western, central and south-eastern region in the present study, where gneissic rocks are at shallow depths. Major portion of the study basin is charecterised by medium potential zone. High potential zones are noticed in the north-western, south-eastern and in some places of central parts of the study basin, where the thickness of the weathered overburden is relatively high. The high and medium potential zones are promising prospective areas for future exploration and development of groundwater in the study basin (Map-4).



Map - 4: Hydrogeomorphological, Lineaments and Groundwater Potential map of the study basin.

7. CONCLUSION

The Dakshinapinakini river basin is 6th order with a dendritic to sub-parellel drainage system. Peninsular gneisses and associated ancient supra-crustal rocks giving an age ranging from 3 to 3.4 million years. The major set of fractures / lineaments are in NW-SE direction and other set is in NNE-SSW directions. The rocks are crystalline, hard and massive which are devoid of primary porosity, but the presence of joints, fractures and fissures act as reservoir and conduits for groundwater percolation. The contact zones between gneiss and granite, granitic gneiss and laterites have proved to be more successful for groundwater occurrences in the study basin.

Based on the hydro-geomorphology the Dakshinapinakini river basin has been divided into areas occupied by pediplains, residual hills, pediments, valley fill and lateritic uplands. Detailed observation on the hydro-geomorphological conditions of the basin, it is possible to decipher the groundwater occurrence is moderate to good. The groundwater occurrence is reasonably good in valley fill areas and in most parts of the study basin i.e. in the pediplains it is moderate to good. The pediments and residual hills have moderate to poor groundwater potential. The high and medium potential zones are promising prospective areas for future exploration and development of groundwater in the study basin.

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