Study of sub-surface water flow zones at Muguru Adda Halla watershed in Mysore and Chamarajnagar Districts using RS and GIS Techniques

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Abstract - **Water stored to subsurface media through hydrological cycle. For a Groundwater assessment, experimental approaches are usually developed, however, on a regional scale, this groundwater assessment needs to be made into a different parameters, where spatial data of the different contributing factors have to be followed. Contributing factors like lineaments and drainage pattern, lithologic parameter, land use and land cover. This study is better estimate and provide qualitative assessment of potential of the area influencing the groundwater conditions are structure, lithology, vegetation and so on and it is very good in valley regions and in remaining it is moderate to poor depending on the hydrological entity.**

Keywords — Sub-surface water, drainage, lithology.vegetation, Land use pattern valley fill

I. INTRODUCTION

The pressure on water resources is increasing manifold globally, in recent years, due to several factors like population explosion, urbanization, rapid industrialization, irrigation based agricultural practices etc. Added to the human failure of managing this precious resource, climate changes are also causing severe imbalance in replenishing water. Thus, managing the available water resource for a sustainable progress is always a herculean task, and the governments spend substantial chunks of their economy in this sector. Such problems are much more severe in a country like India where the efficient management of any resource is pathetic. The population density, social and economic interfaces are adding to this problem. In spite of rapid advancements in technological know-how's, effective water management is still an area of great concern. Launching of satellites and probing of the earth remotely, by these satellites, is a hallmark feature of the last two decades, which has greatly enhanced our understanding of the surface dynamics and resources base. Hydrogeology has been an area of the biggest beneficiary of remote sensing. It has enhanced our understanding of local and regional, lithological, structural and geomorphological features more clearly, thus providing a better insight into surface and sub-surface dynamics of water and its utilization and management. For effective monitoring and management of any natural resource many methods are adopted. In the present situation, there is an imbalance between recharge and withdrawal of ground water which needs to be overcome through detailed investigations. This is especially

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true in hard rock terrains, which constitute large parts of Karnataka, including the study area. Hence suitable techniques need to be developed for mapping prospective zones.

Study Area: The Muguru Addahalla watershed spreads in two districts viz. Chamarajanagar and Mysore in southern part of Karnataka. **(Fig.1)** The spatial extent of the study area is 248.827 sq km. The area is covered in survey of India toposheet numbers 57d/16, 58A/13 and 57H/4. It is bound by north Latitude of Lat 11˚ 58' 20.78'' N to 12˚ 12'33.67" N, and East longitude of, 76˚ 52' 50.34" E to 76˚ 59' 25.68" E. The topomap of the area is shown in **Fig.2**. The satellite image of the area is shown in **Fig.3.** The area is well connected with all-weather motarable road **(Fig.4)**

II. PHYSIOGRAPHY

Physiographically, Muguru Addahalla watershed forms 'Southerrn Maidan' region of Karnataka. It is bound by the Doddasampige Reserve Forest area in the east and Suttur village in the west. River Cauvery is towards North, and city Chamarajanagar towards south. The Muguru Addahalla originates at Ummattur gudda in the south and it joins Cauvery river near the village Ayyanurhundi. The maximum elevation of the area is 900 m (MSL) at Ummathuru gudda and minimum of 540m (MSL) at Muguru Addahalla where it joins the Cauvery river. The rest of the area is constitute gently dipping plains, dissected by shallow rivulets. Much of the area is under cultivation.If you want to submit your file with one column electronically, please do the following:

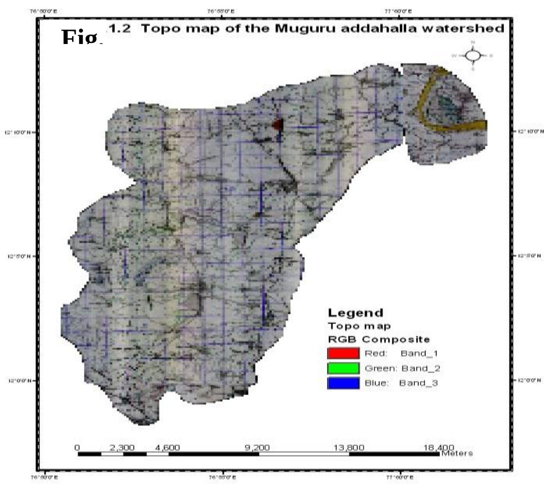

Fig 2.1: Topo Map of Muguru Addahalla Watershed

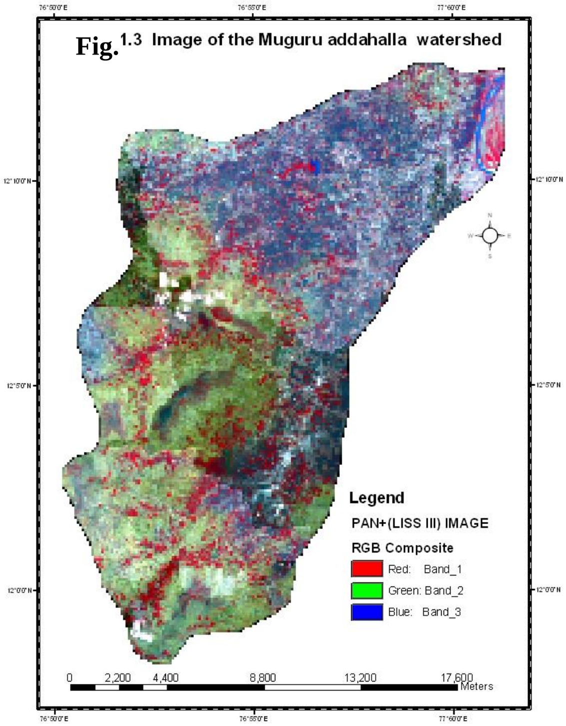

Fig 2.2: Location Map of Muguru Addahalla Watershed

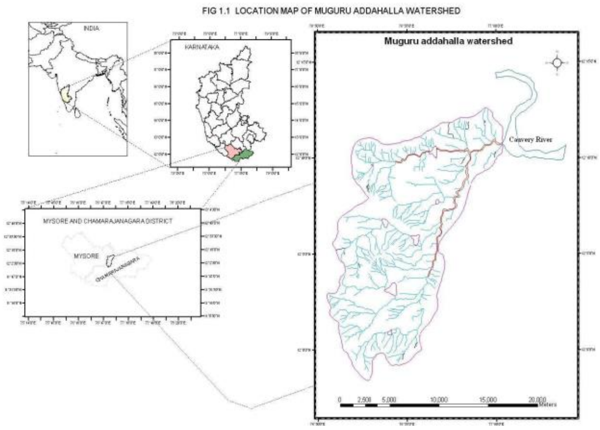

Fig 2.3: Image of Muguru Addahalla Watershed

III. MATERIALS AND METHODS:

In recent years, extensive use of integrated approach for extracting ground water prospect zones in hard rock terrain using remote sensing and GIS techniques (Venkatachalam et al., 1991 Haridass et al., 1994; Chi and Lee, 1994; Krishnamurthy et al., 1996; Pal et al., 1997). The methodology includes generation of thematic maps such as lithology, landforms, structures, land use/land cover, soil slope maps on 1:50,000 scale using IRS 1D (PAN+LISS III) merged satellite data and other collateral information.. Lithological Map is derived from published geological map on 1:2, 50,000 scale and updated using satellite data.

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Geomorphology (Landforms), land use/land cover and lineament maps were interpreted from satellite imagery. Slope map is prepared from SOL India topographical sheets on 1:50,000 scale. Soil map of the study area is derived from 1:2, 50,000 scale soil map of Karnataka prepared by NBSS & LUP. All thematic maps were converted into the vector format by digitization. Depending upon the perceived importance of their role in occurrence and movement of ground water, weightage has been assigned for individual themes. All the maps were integrated by overlay techniques using GIS to delineate ground water potential zones.

Sl. NO	Lithology code	Area/sq km	Percentage area cover
1	GTGN	247.0975	99.28
2	DYKE	0.9647	0.39
3	UM	0.2144	0.09
4	AMP	0.6084	0.24

Table.1 Categorization of lithology based on Quadrangle map of GSI, Using remote sensing and GIS

IV. Results and Discussion:

Geology of the area: From the hydrogeological perspective, the rock types of the studied watershed are generally poor for groundwater infiltration, owing to their poor porosity and permeability. However weathering has produced vast structures of soil cover, which are to a greater extent, facilitates sub-surface infiltration. Also, the contact zones between different lithounits (though small) could augment sub-surface movement. However, dykes, as mentioned earlier, have a significant roll to play, though in other sense, that most of the times they serve as barriers and could store copious ground water. The textures and structures of the rocks also influence weathering besides playing vital role in the ground water accumulation, movement and acquiring chemical characteristics. Large scale structures like faults, shear zones and other week planes affect greatly the ground water accumulation and surface run-off. Thus hydrological studies(Albergel.J., Lamachere J.M., Lidon B, Mokadem A. Vandriel W.(ed),(1993) are incomplete without the study of geological formations. Porosity and permeability factors in rocks are also important characteristics to evaluate transmissivity, specific retention and specific yield. These properties vary from place to place and thus studying geological properties is necessary for quantifying them

Lithologically, study area, as mentioned is made up of gneisses, amphibolites, ultramafics and younger dykes. Among them gneisses are the predominant lithology. They are part of the Peninsular Gneisses, which are predominant in the southern part of Karnataka. Amphibolites and ultramafics are noticed as enclaves within the gneissic rocks. Dykes represent the youngest episode of igneous activity. Besides the different rock types, drainage pattern(Agarwal.C.S. 1998). Joints, fissure, fracture and different lithological boundaries have been studied. Demarcation of lineament in different areas and their relation to rock types and lithologic contacts has also been studied. Similarly different litho boundaries have also been recognized **(Table.1).**

Hydrogeomorphologically vally fill yield good water compare to other zones.Pediplain yield good to moderate ground water depending on the lothological basement.piedmont zones yield moderate to poor with respect to fracture zones present in it.Lineaments are good potential ground water zones.

Landuse landcover pattern increases the ground water storeage capacity.Vegetation and trees are highly helpful to hold the running water on the surface and facilitate to increase the infiltration capacity.

Soil pattern indicates the infiltration capacity of the ground water.Gravel and sand having more porosity compare to silt and clay.Clay is having very less amount of porosity and permeability to implies very less or no storeate of ground water at the same time Gravel and sand store good amount of ground water.

Remote Sensing and GIS play diminent role to Identifying and mapping of different thematic maps with the help of Survey of India topomaps on 1:50.000

Scale map.Thematic maps like Hydrogeomorphology, lithology, landuse/land cover, soil map and alsoslope aspect and altitude map.All these maps are very helpful to Identifying and mapping the water potential zones.

GTGN : Gneisses granodiorite, tonalite and migmatite gneiss

AMP : Amphibolite and hornblende schist

UM : Metaultramafics, metapyroxenite, serpentinised dunite and peridotite

Dyke : Dolerite\Gabbro dyke

GSI : Geological survey of India

GIS : Geographical information system

Among the different lithologies granitoids cover largest area of 99.28% followed by Dyke (0.39%) and Amphibolites (0.24%) Ultramafics occupy least area (0.09 %.).

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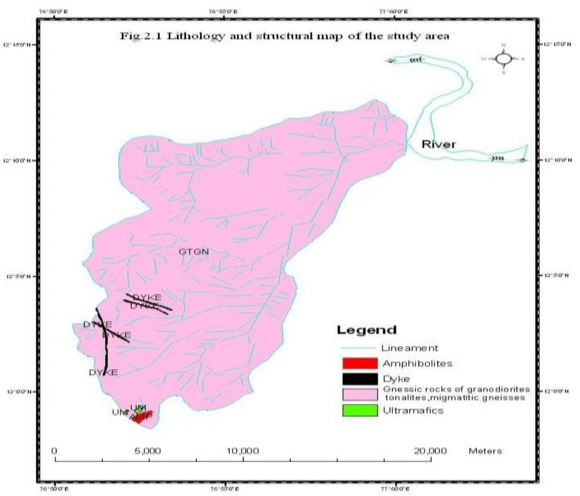

Fig 4.1: Lithology and Structural Map of the Study Area

Lineaments area displays shears, joints, faults and lineaments which appear to be moderate in the intensity of developing .They are small to moderate in extent with variable dipping. They too have played some role in ground water percolation. As joints, fractures, and shears are smaller and localized, they could not be quantified through remote sensing data. However linear features like lineaments have been quantified. Most of the drainage network in the study area is controlled by these lineaments (Fig.2.1). Many structural features like folds axis, faults and shears, besides dyke bodies normally appear on remote sensing data products as lineaments. Often the lineaments develop in a systematic way and hence a methodological statistical analysis of lineament pattern provides information regarding their tectonogenesis and relevance to ground water movement.Going back to history, the term lineament was originally used by Hobbs (1904), to describe linear features that are "significant lines of land scape" although linear features had been discussed since 1800's (Hodgson , 1974). Lineaments are both local and regional features.) opined that the term lineament is preferentially used to define the unidirectional earth features of larger magnitude.

The other synonyms related to lineament that are linear, lineation, geofracture, suture, mega fracture and shear. Several tectonic process and related parameters are involved in the formation of lineaments (Rakshit an Prabhakara Rao, 1989) and they act as neotectonic windows). Lineaments have major tectonic, magmatic, economic and neotectonic significance, and their role in surface and sub surface hydrology is assuming more and more importance. From the point of their origin Sonder (1947) has developed global shear pattern. It envisages lineaments as regular fracture patterns that pervades the globe, generated by the forces of the rotation of the body on its axis. Flattening of the earth in north-south along it's axis would produce a set of north-trending tensional and east-trending compressional weakness zones and northwest and northeast trending shears. These would be propagated throughout the life of the planet. later recognised such a pattern on satellite imagery of the moon and other planets, and visualized similar dynamics. Lineaments of the study are investigated and interpreted in the background of their regional studies carried by early workers. Kowalik and Gold (1976) suggested a classification of lineaments based on their lengths as shown in **Table.2.**

Sl. No.	Lineament Class	Length(km)
1	Short /Minor	1.6 to 10
2	Intermediate	10 to 100
3	Long / major	100 to 500
4	Mega	>500

Table 2. Lineament Classification (Based on Kowalik and Gold 1976)

Lineament range in km	Total length of lineament in each class(km)	Total no of lineaments
Less than 1Km	113.80	188
1 to 2km	67.43	51
2 to3 km	137.47	12

Table.3 Distribution of Lineaments in the study area

The lineaments are running in N-S, E-W, NW-SE, NE-SW, NNE-SSW, NNW-SSE directions (Fig.2.1). It can be seen that 2 to3 km lineaments are align along the stream course, shears and less frequently along the contacts of different litho units. One to two km and less than 1km lineaments are found along and sides of the drainage segments. Joints, fracture and fissure zones and contact zones of litho boundary. All these characteristics are identified on the satellite imageries, based on parameters like colour, tone, texture, pattern and association. Lineaments, especially tectnogenic ones are known to be excellent sites for groundwater movement and storage. The ground water potential of the study area has been appraised from this angle, because good net-work of lineaments, as is found here, contribute significantly for ground water potential. As such, the bedrocks of the study area are not so favorable for ground water movement, due to their inherent properties, but are rendered considerably favorable due to the existence of lineaments.(Table.3)

Soil cover, Vegetation and land use /Land cover pattern:

Soils play an important role in the accumulation of ground water. Soil structure and texture which are controlled by the percentage of sand, silt and clay play a

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dominant role in the ground water infiltration. The sand (0.06mm to 2mm in diameter) helps in high infiltration whereas the silt (0.002mm to 0.06mm diameter) is having medium infiltration and the clay below 0.02mm diameter is having low infiltration. Based on the physical property and broad chemical composition of the soil cover hydro soil map of the study area has been prepared.

This map has been useful in delineating run-off potential zones.Vegetation also plays important role in run-off process. Different type of crop pattern like forest and plantation crop is part of land use/land cover map which are also important for proper groundwater management. Waste lands have to be prepared in the land use/land cover map for proper groundwater management. For this infrared and visible regions of the electromagnetic spectrum are useful. Different shades of crop pattern can be easily identified by the red band of false colour composite (FCC). The high water concentration in any region can be inferred from the thickness of the vegetation which is represented in dark red colour on the imagery.The land cover encompasses natural cover of the land like hills, rivers and related geomorphological features. Whereas the land use signifies the natural cover of the land by human activity. For example all buildings, cities, and agricultural grazing lands etc. The proper land use pattern improves agricultural production like food and fodder and contributes for the ecological balance of any area. Thus the land cover and land use development is based on the integrated management of soil, water and other resource management to develop appropriate cropping and other agro techniques adopted for sustainable production.

Soil cover study: Soil serves as a natural medium for the growth of the plants. Next to water and air, soil is most essential for the existence life existence. Soils are the basis of support for most life and a source of nutrients for all kinds of life in one way or the other.

It is well-known that soil is produced by the weathering process. It gets mixed with decayed vegetation and other organic matter and forms humus rich top soil over the parent rock or at some distance which forms ‘A’ horizon. Below this would be ‘B’ horizon and followed by ‘C’ horizon. Before bringing out the characteristics of soil types of study area.

Geomorphology:

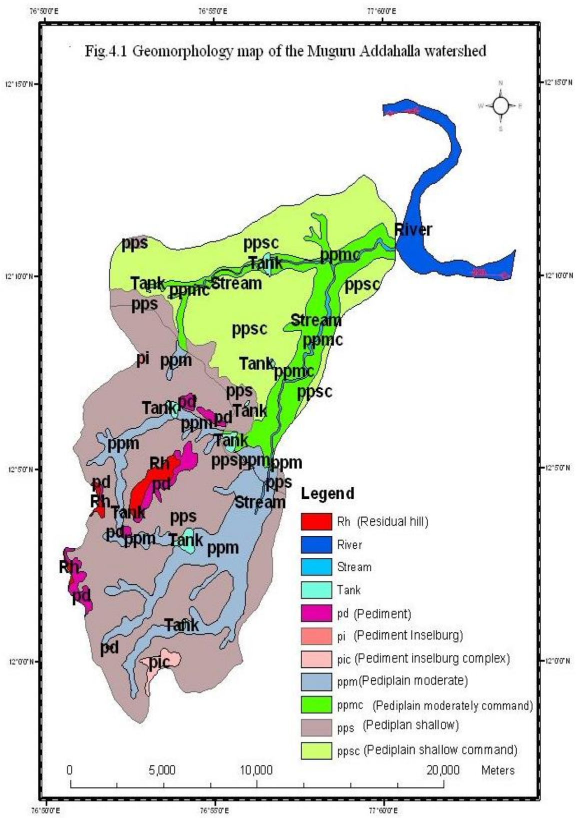
Geomorphology is the science of the landforms and their systematic study is important so as to interpret them as signatures of the past and ongoing geological processes. These geomorphic features have great bearing on water resources of any area. Certain agents like rivers, glaciers, winds, etc relentlessly operate on the earth crust to bring about the changes of degradation and aggradation and these features are important from the point of understanding surface and subsurface water movement.

Pediplain shallow: They are formed by coalescence of buried pediments, where a thick overburden of weathered materials accumulates. The intensely weathered areas of granitoids constitute these landforms. Varying thickness of shallow over burden can be observed in such areas. Weathering of the bedrocks has been initiated by fractures, joints and minor lineaments. The area covering by such land forms is huge in the study area and account for 107.81 sq

Fig 4.2: Geomorphology map of Muguru Halla Watershed

km (43.31%of the total area). These land forms are spread in Hosahalli, Badanaguppe, Hanumanapura, Honnegowdanahundi, Karya, Kuderu, Demahalli, Hallikerehundi, Dasanuru, Ummatturu, Jennuru, Jennuru Hosuru and Bagali, Hosuru Hundi .(Fig.4.3).

Pediplain moderate: Flat and smooth buried pediplain and pediment with moderately thick overburden are called pediplain moderate. Thickness of weathered material is high compare to pediplain shallow. The weathered materials are chiefly constituted by gneisses and migmatites. They are extended towards south-west of Demahalli upto Dasanur, Ankushayyanahalli, Badanaguppe, Karya and Hanumanapura villages (Fig.4.4) covering a total area of 34.1008 sq km (13.7%of the total area).



Rainfall pattern in the study area : To assess the climatic condition and rainfall pattern, 20 years annual average rainfall data has been taken for T.Narasipura, Nanjangud

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and Chamarajnagar taluks (which fall within the studied watershed) to evaluate the precipitation potential and hydrological conditions. Other meteorological data of Mysore and Chamarajanagar districts have also been collected for assessing hydrogeomorphological conditions.

In the study area the premonsoon starts from January and ends at May and southwest monsoon starts from June and ends at September. Northeast monsoon starts from October and stretch up to December. The annual rainfall data accounting is from January to December. The rainfall data .collected was from 1987 to 2006 and is presented in Table 4.2.

Its graphical presentation is shown in Fig.4.13. Annual average for 20 years in T.Narasipur taluk is 759.18 mm. **Nanjangud** taluk is 775.075. , m and Chamarajanagar taluk 806.833 mm. Annual average of 20 years rainfall data of the above three i.e is for the study area is 780.325 mm.

From the climatic studies it can be inferred that annual maximum temp. is 36.2˚C and average annual extreme temp is 39.4˚C. Average rainfall of the study area is 780.325 mm. These factors are critical for agriculture productivity in the study area.

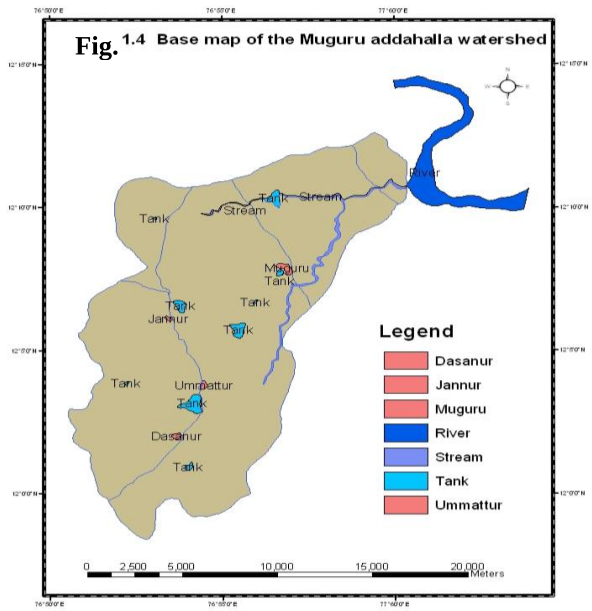

Fig 4.3: Base map of the Muguru addahalla water shed

V. CONCLUSION

Integration of thematic map prepared from remote sensing and collateral data using GIS yields more accurate results. Excellent groundwater potential zones are found either side of lineament and Cauvery River. Major portion of southeastern part are occupied by poor to moderate potential zone due to its topography and forest cover. Good prospect zones are enlighten in nearly level to very gentle slope with agriculture land. Out of 2522 Sq.km 50.51, 87.21, 123.14, 5.30 sq km falls under excellent, good, moderate and poor ground water prospect zones respectively.

Vally fill zones yield excellent water potential zones. Pediplain zones produce good to moderate water potential zones and piedmont zones yield moderate to poor potential zones.

Water is very important life supporting resource. We have to develop ground water potential zones through artificial water harvesting structures. We recommended to grow vegetation along down stream of the parcel land is facilitate to develop ground water potential and avoid soil erosion. The present study will greatly helpful to development, preservation and utilization of both surface and sub-surface water resource. Remote Sensing and GIS play a vital role in Identifying and monitoring the both ground and surface water resource using multi season data.

Different thematic layers like hydrogeomorpholoty, landuse/landcover, soil, hydrosoil, slope analysis map help to estimate the potential zones of ground water using RS and GIS techniques.

REFERENCES

[1] **Hobbs, W.H. (1904)** Lineament of the Atlantic border region. Geol. Am. Bull.15.,pp.483-506.

[2] **Hodgson, R.A. (1974)** Review of significant early studies in lineament tectonics. In proceedings 1st I nternational conference of the new basement tectonics. Utah Geol.Asso.Publi.5., pp.1-10.

[3] **Kawalik, W.S. and Gold, D.P., (1976)** The use of landsat imageries in mapping lineaments in pennsylvanis: proc. First. Int. Cont. on the new basement tectonics Utah Geol, Assoc, pub., no.5,pp.236-247.

[4] **Rakshit, A.M. and Prabhakara Rao, p.(1989)** Megalineaments on the face of the Indian sub continent and their geological significance, Mem. Geol. Soc. India. No.12, pp.17-94.

[5] **Sonder, R.A.(1947)** Discussion of "shear patterns of the Earth's crust by F.A Vening nienisz:Am.Geophy.Union Trans.v. 28.p 939-945

[6] **Agarwal.C.S. (1998)** Study of drainage pattern through aerial data in naugarh area of Varanasi district , U.P. Jour. Indian Soc. Remote Sensing, 26(4): 169-185.

[7] **Albergel.J., Lamachere J.M., Lidon B, Mokadem A. Vandriel W.(ed),(1993)** Miseen valeur agricole des bas-fonds au Sahel. Typologie, fonctionnement hydrologique, potentialites agricoles. Rapport final d'un projet CORAF-R3S. Quagadougou, Burkina Fasa, CIEH,335P.

 DOI : 10.35291/2454-9150.2021.0423

[8] **Krishnamurthy. J., Venkatesha Kumar, N., Jayaraman, V. and Manivel, M. (1996)** an approach to demorcate groundwater potential zones through remete sensing and a geographical information system.Intl.Jour.Rem.Sen.v.17(10), pp.1867-1884.

[9] **Patel, M.E., and Prabhakar, B.C. and Lokesh,K.N.(2001)** Hydrolitho units and their groundwater potential zones in Hirehalla basin, Shimoga District, Karnataka.Abs.Vol.3rd conv. of MSI and National seminar, Mysore.

[10] **Ramachandra Rao, M.E. and Suryanarayana, J.N. (1955)** Geological exploration for groundwater in crystalline rocks. Proce. of the sym. on groundwater,pub.No.4,pp.196-204.

[11] **Ramaswamy, S.M. (1997)** Remote sensing for natural resources survey and environmental modeling. Lecture notes, Workship on Geohazards, Feb. 1-4, 97, pp.SHIR1-SHIR16

[12] **Sharma, D and Jugran, D.K. (1992)** Hydromorphogeological studies around pinjaurkala Amb area, Ambala district (Haryana), and Sirmur district (Himachal Pradesh). J. Indian Soc.Remote Sensing.20(4):281-286.

[13] **Sharma, K.k. and Sastri, J.C.V. (1986)** Electrical resistivity surveys for groundwaters-Acase study from the Regional college of education, Mysore,Jour.AEG, Hyderabad,7,1,pp.37-42.

 DOI : 10.35291/2454-9150.2021.0423