

Groundwater Investigation of Keernahalli Sub-Watershed, Periyapatana Taluk, Mysure District, Using Remote Sensing and GIS Techniques

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Abstract:Present study area is facing shortage of water for domestic irrigation and industrial purpose, because of the inadequate surface water resource, the demand for ground water resources is increasing every year in order to meet this growing demand for ground water it is essential to identify the ground water potential zone of the area through scientific approach and using various thematic maps i.e. (Base maps, Hydro geomorphological, Geological, structure, Drainage, slope, Land use Land cover and Ground water prospect zone maps). The Ground water availability of the study area, based on above conditions classified into very good, good, moderate, poor to nil. Thus the study also proves that remote sensing and GIS when synergistically used, provide ample scope for the integration of Spatial and Non Spatial data which were successfully adopted to systematic approach and to decipher the probable potential zone of ground exploration of area to most scientific and unbiased manner.

KEYWORDS: Ground water investigation of Keernahalli sub watershed using RS and GIS.

I. INTRODUCTION

Karnataka is basically an agrarian state and majority of the area is under rain fed agriculture, Majority of the taluks experience droughts more frequently, developing such areas on watershed basis will help combat to combat drought. Various projects are being implemented by different departments to develop watersheds. Ground water forms a substantial part of the total water resources and provides water for irrigation, municipal supply and industrial use. Ground water gets replenished by the natural or artificial process of recharge [1]and [2]. Groundwater constitutes important sources of water supply for various needs, such as domestic, industrial and agriculture. Development of a nation is highly depended upon the groundwater resources. Increasing population and social changes reflects adversely on the groundwater. Main source for ground water is precipitation resulting in drainage flows through fracture zone on the earth surface. In order to ensure a judicious use of ground water, proper evaluation of ground water resource is required. Integration of remote sensing and GIS techniques provides an appropriate platform for the holistic analysis of diverse datasets for decision making in evaluation and planning of ground water potential. 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, Hydrogeology has been an area of the biggest beneficiary of remote sensing [3] and [5]. It has enhanced our understanding of local and regional, lithological, structural and geomorphologic features more clearly, thus providing a better insight into surface and sub-surface dynamics of water and its utilization and management.

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II. STUDY AREA

For effective monitoring and management of any natural resource many methods are adopted. In this direction, lithology, lithological contact zones, structures, landforms, geomorphology land use/land cover, soils, lineament and drainage network etc. are the essential inputs for the management of natural resources especially water resources. 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 true in hard rock terrains, including the study area. Hence suitable techniques need to be developed for mapping prospective zones. The study area “Peryapatana taluk” sub watershed lies between latitude $12^{\circ} 20' 42''$ and longitude $76^{\circ} 7' 30''$ of Mysore district situated in the southern part of Karnataka. This District receives the variation in the annual rainfall from year to year is not large during the 85 years from 1901 to 1985. The highest annual rainfall amounting to 156 percent of the annual rainfall that occurred in 1903 and the lowest occurred in 1918 and not much variation is seen for the last 85 year period. The annual rainfall was less than 80% percent of the normal rainfall in last 7 years. This district is generally semi irrigated and remaining part is rain fed and drought prone area.

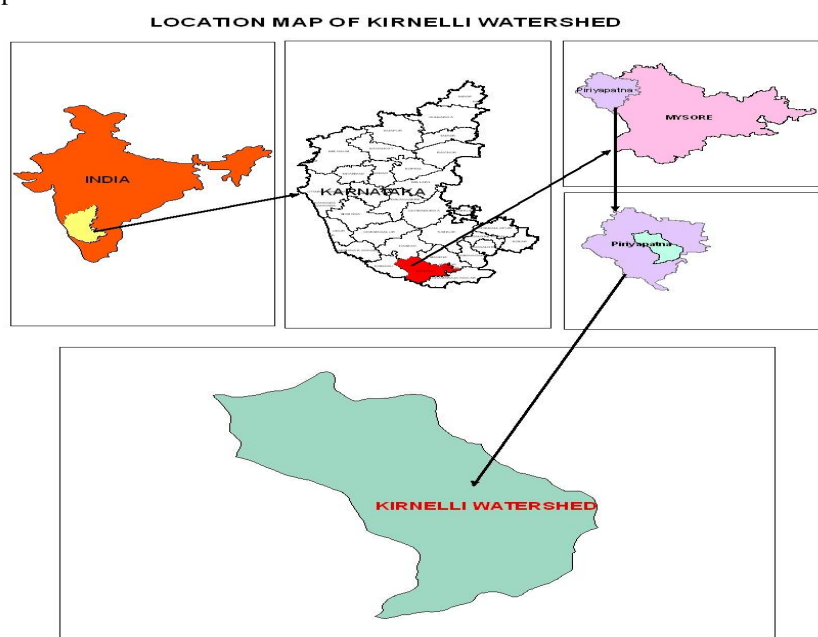


Fig.1.Map showing the keernahalli sub watershed

III. METHODOLOGY AND MATERIAL USED

DATA COLLECTION : Different data products required for the study include SOI TOPOSHEET bearing number—57D/3 on 1:50,000 scale data of PAN+LISS III GEOCODEDE Satellite imagery obtained from KRSAC and remaining needful data from different organization (govt. or as well as other agencies) and other data are rain fall data and demography data etc. have been adopted.

REFERENCE DATA : The spatial data used consists of reference data containing of maps prepared by different government, organization, which are the key source for the reference. the reference data or maps used in this study and the source are specified.

MAP NAME	ORGANIZATION
Topomap	SOI (survey of India)
Geology/Lithology map	GSI (Geological Society of india)
Soil data	Agriculture dept.

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Hydrology

CGWB/SGWB

The step by step procedure was adopted to prepare the hard copy of the study area using topomaps obtained from soi. Conversion of Raster data to vector data of the baseline digital map and preparation of thematic map by visual interpretation were followed.

Creation of the baseline data by digitizing the map and digital database is prepared using AutoCAD software.

Preparation of thematic map from SOI toposheet and thematic map like geology, lineament pattern, drainage network, soil, land use/land cover, geomorphological units and their interpretation for surface flow and groundwater accumulation prepared on the visual interpretation of satellite image in conjunction with the existing map/literature.

Field visits for checking the interpretation collecting the additional information, incorporation of field observation in the thematic maps.

Integration of above thematic maps and preparation of ground water potential map, incorporation of corrective/modification based on the collected data, final output generation using GIS SOFTWARE is done.

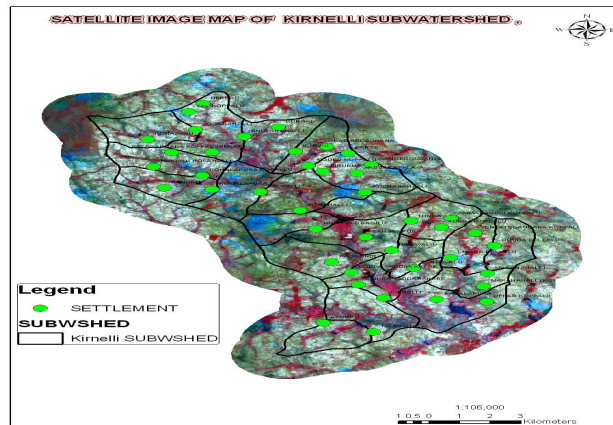


Fig.2 Sattelite image of keernahalli Sub watershed

The watershed map is prepared in accordance with the national watershed atlas 1990 and according to India divided into 6 regions out of which the present study area comes under region bay of Bengal, Caveri basin, krisnaraja catchment, Caveri main sub catchment, laksmana thirtha watershed, keernehalli subwatershed and river flow into bay of Bengal.

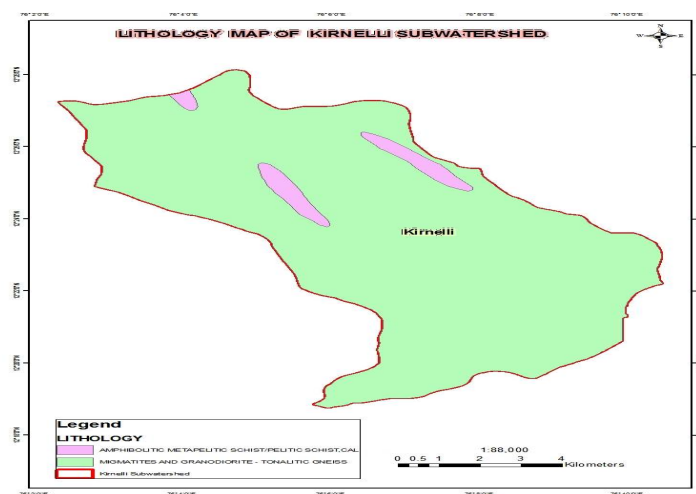


Fig.3 Lithology map of keernahalli sub watershed

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It is mainly made up of gneisses, amphibolites; and in closepet granite and some places granitic rocks are intruded into the gneisses. Among them gneisses which are predominant in rock type.

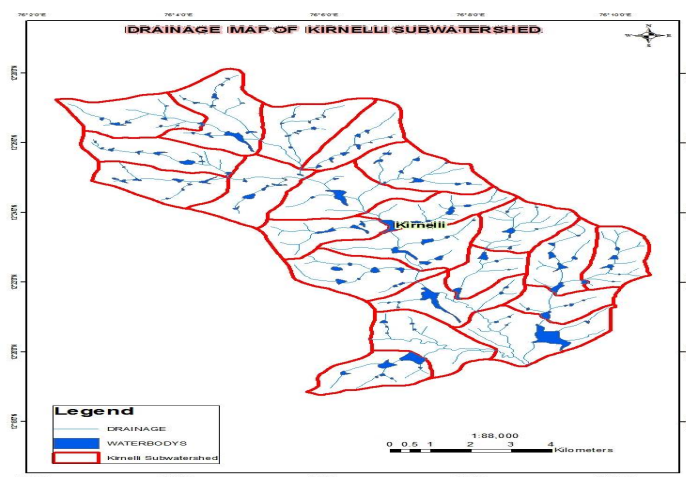


Fig.4. Drainage map of Keernahalli Sub watershed

This map provides information on drainage, watershed boundary and distribution of surface bodies, information. are derived from drainage morphometry to understand and characterize hydrological response of a watershed. Drainage map has been derived from SOI topo sheets on 1: 50,000 scale and updated with satellite imagery. The broader classification and codification of watersheds adopted are based on watershed atlas of India (AIS & LUS). The classification according to the criteria is basin, catchment, sub catchment, watershed, sub watershed and micro watershed.

The drainage of area is typical of arid and semiarid areas. It comprises of small depressions and seasonal streams. The drainage of the area is dominated by deeply incised, sand filled, seasonal streams flowing from east to west. These sands are a locally is very important source of water during the dry seasons when water can be found within a few meter of the study area. The study area mainly made up of hills on the one hand and pediplains on the other, forming irregular and diverse nature of topography

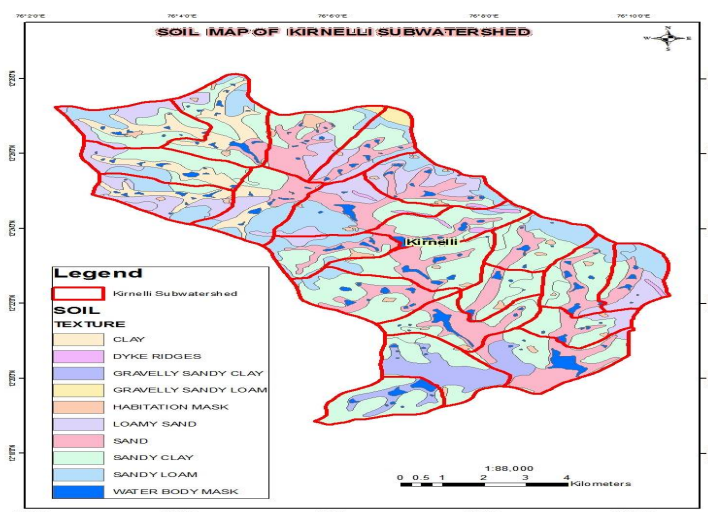


Fig.5. Soil map of Keernahalli sub watershed

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Characterization of soils, accurate mapping of different kinds of soils and scientific criteria for land evaluation and interpretation of soils for multifarious land uses were carried out using information derived from satellite image. SOI Topo maps and slope maps. The soils have been grouped into land capability classes which provides a rational basis for evaluating resource potentials/ limitation in conjunction with climatic and terrain parameters.

SAND SOIL:

Sand soil types have a gritty, coarse texture, its particles are visible to the eyes, making it's the largest particles of all the soil classes Sandy soil drain quickly and warm up easily

SILT SOIL :

Silt has a fine, smoother texture than sand, but still has a gritty feel, because it is slippery, when wet if you squeeze a ball of silt soil in your hand, it doesn't break, but change shape easily, silts particles are tiny and only visible with a microscope. Silt is a healthy soil for farming, but it erodes easily.

CLAY SOIL

Clay becomes sticky and clumpy when wet it also has fine particles, only visible with a microscope. Clay soil tends to have poor drainage and it is slow to warm up. It is difficult to plant in clay soil since it is hardness to a consistet and nearly as hard as concrete. Plants have a hard time establishing their roots in the compacted soils, while its hard and clumpy nature supports for the high concentration of nutrients .

LOAM SOIL:

loam is considered as the perfect soil, the net workable type, it is a combination of all the soil types, but usually has about half sand and half silt with a little bit of clay soil mixed . Sometimes it is described by adding one of the other classifications, such as clay loam, sand loam etc. It has enough large and small particles so both air and water can easily flow through it and plant grow easily in this types.

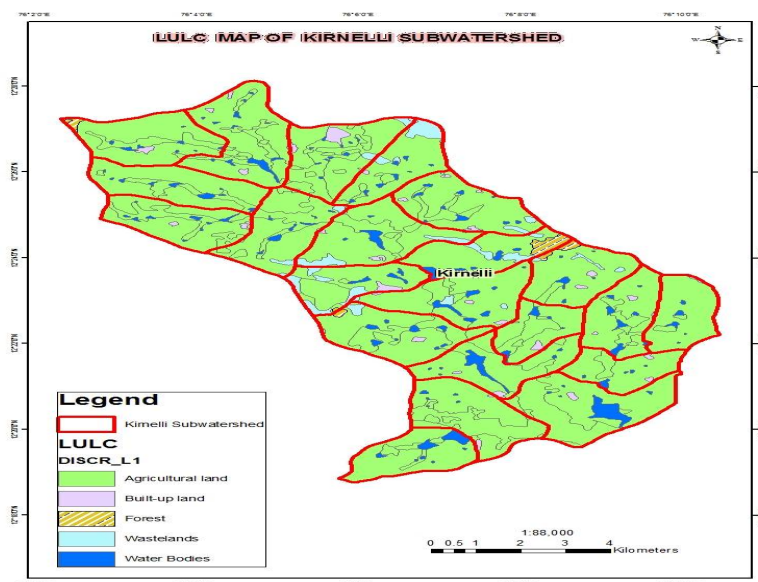


Fig.6. LU/LC Map of Keernahalli Sub watershed

This map provides information on existing land use/ land cover pattern and their spatial distribution. The land use land cover maps were prepared using satellite images in conjunction with collateral data like topo maps. The land use/ land cover classes delineated are agricultural land (crop land), fallow land, plantation, forest (evergreen/semi evergreen, deciduous, scrub etc.), wastelands (salt effected land, water logged land, gullied / ravenous land, barren, rock/stony

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waste etc.) water bodies (Rivers, streams, canals, lakes etc.) and settlement. The current land use is assessed for its suitability in the light of land potential before suggesting alternate land use practices.

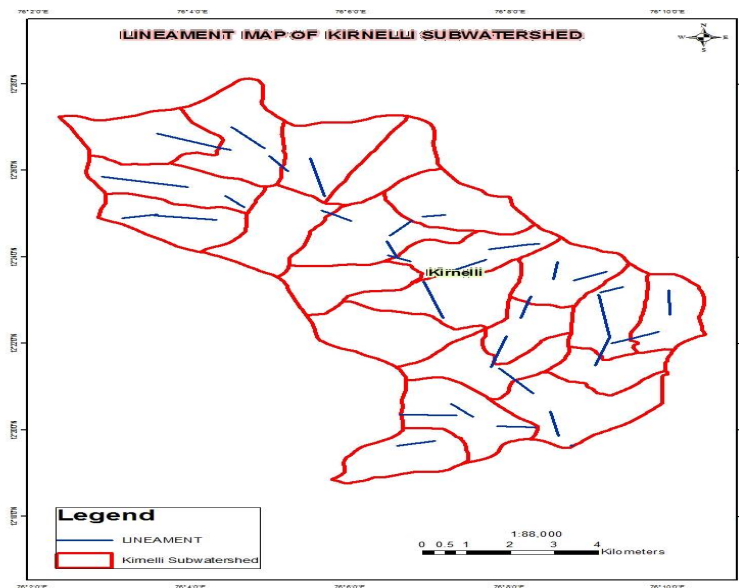


Fig.7 Lineament Map of Keernahalli Sub watershed

In general lineament can be defined as a long linear or curvilinear feature, which is formed by tectonics. The lineaments are also interpreted from the satellite imageries on the basis of the morphological expression and anomalies and structural trend lines, break in slopes, long and linear fracture valleys, soil tone linearity's etc. Lineaments have mostly the azimuth directions of NS to SE along the drainage patterns

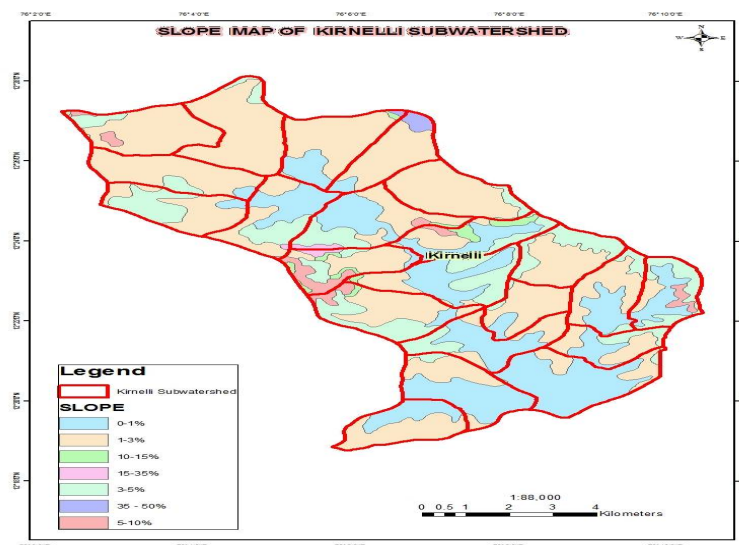


Fig.8, Slope map of Keernahalli Sub watershed

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SLOPE:

Slope map aspect and altitude are important terrain parameters used for land capability and irrigability assessment, Fig.8 Slope map of Keernahalli Sub watershed
formulating soil and water conservation measures etc. The map has been prepared based on the contour information available on 1:50,000 scale soil toposheet maps. The slope values were grouped into seven classes viz, the area with nearly level (0-1 %) fall on the very good category due to the nearly flat terrain and relatively high infiltration rate. The eastern portion of study area (60% of the total area) fall on the category very gently sloping (1-3 %) this is consider as good for ground water storage due to slightly undulating topography with some run off, gentle sloping (3-5%)causes relatively high run off an flow infiltration and categorized as moderate, moderately sloping (5-10%) strongly sloping (10-15%), moderately steep to steep sloping (15-30%) categories are considered as poor due to higher slope and run-off.

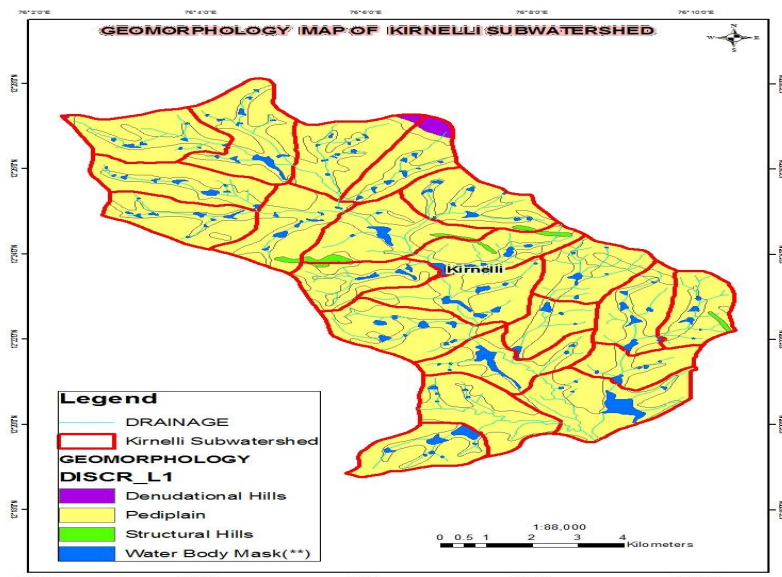


Fig.9 Geomorphology map of Keernahalli sub watershed

Information of landforms is an important input for land management , in the present study pan + LISS data and the survey of India topographic maps are the main input data for preparation of geomorphological map. The geographical units are the delineated based on the image characteristics like tone, texture, shape, colour and association. The relief slope, extent of weathering, type of weathered material and overall assemblage of different landform play an important role in defining the ground water regime, especially in the hard rocks. Geomorphology was assigned highest weight because it has a dominant role in the movement and storage of ground water in the study area (Thomas et al 2009). Visual interpretation of digitally enhanced images enables identification of the varoius geomorphic units in the present study. Various land forms identified in the study area in the figure, they are structural hills, denudation hills and weathered pedi plains.

STRUCTURAL HILLS :-These are formed predominantly by metamorphic rocks, these are occupy western part of the study area. Because of high slope and relief groundwater prospect in this zone is considered as poor.

DENUDATION HILLS : broad uplands of considerable elevation, steeply sloping all the direction as seen.

PEDIPLANIN : Gently undulating plain of large areal extent, often dotted with inselbergs by the coalescence of several pediments. Based on the depth of weathering, weathered pedeplain are classified into three categories namely Pedeplainshallow weathering , Pedeplainmoderate weathering and Pedeplaindeep weathering

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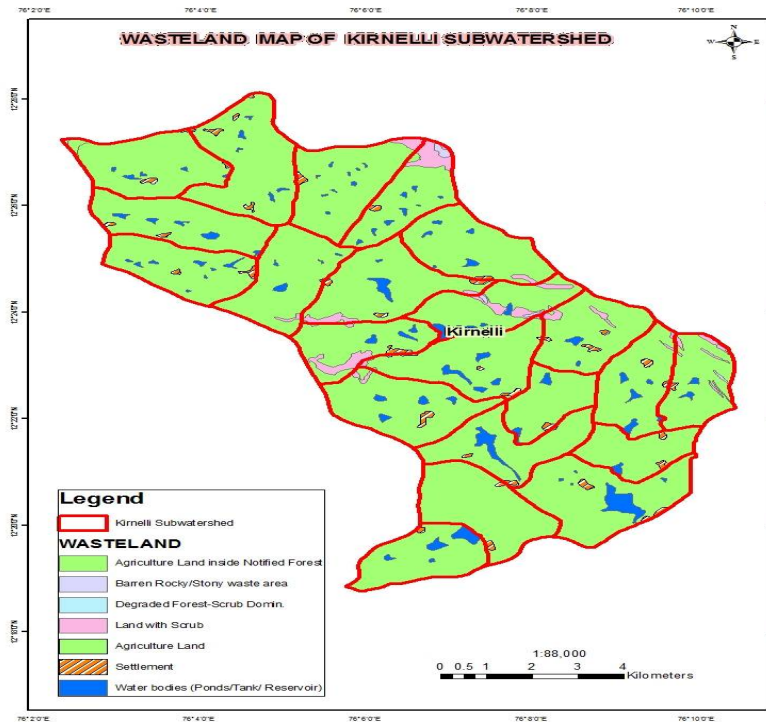


Fig.10 Wasteland map of Keernahalli sub watershed

Wastelands may be described as degraded land, which can be brought under vegetative cover with reasonable effort and which is currently under unutilized land. This land is deteriorating due to lack of appropriate water and soil management or on account of natural causes. Wastelands can result from inherent/imposed constraints such as by location, environment, chemical and physical properties of the soil or financial or management constraints. This class includes settlement, land with scrub and water bodies.

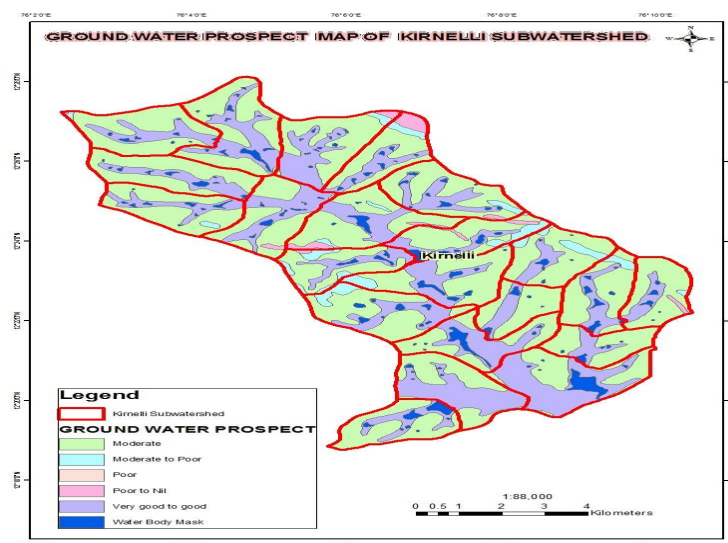


Fig.11.Grounwater prospect map of Keernahalli subwatershed

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The hydro geomorphology maps are prepared using satellite data with limited field surveys. Geological, geomorphological, structural and hydrological aspects have been studied to evaluate ground water prospects. The geological details like lithology/rock types and structural trend lines were delineated using geological maps and satellite data and incorporated on hydro geomorphology maps to arrive at ground water potential zones. The ground water prospect map depicts zones which are very good to good, good to moderate to poor to nil and also indicates sites for recharging aquifers and water harvesting structures

IV. WATERSHED ACTION PLAN

Under the project action plans for sustainable development of land and water, resources are generated on micro watershed basis, integrating thematic information (Soil, slope, land use/land cover, ground water prospects, land capability/suitability) generated using satellite data along with collateral/ conventional information and socio-economic inputs giving emphasis on community needs based on survey numbers. The action plans are basically the recommendations towards improved soil and water conservation for ensuring enhanced productivity, while maintaining ecological/environmental integrity of the micro-watershed. The action plans also address the identification of sites/areas for surface water harvesting. Ground water recharge, soil conservation measures through check dams, vegetative bunds, etc. It also specifies sites for improved/ diversified farming systems with fodder, fuel wood, agro-forestry, agro-horticulture etc. These action plans are generated jointly by watershed department experts (agriculture, horticulture, animal husbandry and forest) field NGOs and beneficiaries. The action plans are technically scrutinized by district resource group and final approval from zilla panchayat is obtained before implementation of artificial recharge. In order to increase the natural supply of groundwater, people should be made aware about artificial recharge ground water basins. Artificial recharge may be defined as augmenting the natural movement of surface water into underground formations by some method of construction. Recharged ponds and check dams provide a good measure of artificial recharge in hard rock terrains by collecting surface runoff and increasing the surface area of infiltration. Suitability of these structures depends on various factors, which can be identified using GIS techniques, considering the hydrogeomorphology conditions of the area, weightage indexing has been adopted to suggest the ideal locations for artificial recharge using different parameters namely geology, geomorphology, soil, land use land cover, slope, drainage density, lineament

STRUCTURE RECOMMENDED/ ACTION PLAN



Fig.12, Structure Recommended for the Study area

VEGETATIVE CHECK:

VCs are located for the 1st order drains running through agriculture lands having gentle to moderate slopes to check velocity of runoff and further erosion of soil.

a. BOULDER CHECKS

The BCs are located to 1st order drains running through lands having little or no top soil to check runoff velocity and prevent the damage to drains downstream.

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b. VEGETATIVE BOULDER CHECKS

To check the velocity of runoff and conserve soil, VBCs were recommended to streams running through lands having soil with low infiltration rate and high runoff.

c. DRAINAGE LINE STABILIZATION / NALA REVETMENT

The DLSs and NRs were recommended to 2nd and 3rd order drains at the point of sharp curves to prevent damage to stream bunds. Stony masonry work / vegetation cover is given to prevent bank erosion.

d. CHECK DAM

The CDs are located for 2nd and 3rd order drains to check runoff velocity and provide more time for water to infiltrate and reduce soil movement further down.

e. VENTED CHECK

The VCs are recommended to streams which are originating from and running through large forest catchment area at the point of joining plains / agriculture lands to slow down the running water force.

f. DE-SILTATION OF TANK

De-siltation of tanks is recommended to those tanks which are losing their carrying capacity due to encroachment by scrubs but, have more number of water feeding streams to rejuvenate the tank life and productivity and improve ground water potential.

V. RESULT AND CONCLUSIONS

As Remote Sensing and GIS have proven their credibility beyond doubt in natural resources an attempt has made to prepare groundwater potential zone and artificial recharge sites of the study area. An integrated maps have been derived showing ground water potential zones and artificial recharge sites which were reclassified into 1) Excellent 2) Very good 3) Good 4) Moderate 5) poor/nil

Detailed image interpretation was carried out and various thematic maps were prepared. GIS images were generated using ERDAS 8.6 and ARC GIS 9.1. In spite of the fact that the study area is dominated by hard rock such as gneisses, which are generally very good aquifers. The moderate and high degree weathering, moderate joints, fracture and flow contacts are the favorable sites for groundwater occurrences.

The study has shown that the integrated spatial information analysis using parameters of geology, geomorphology, soil, land use land cover, slope, drainage and lineament and intersection of remote sensing data has great promise and potential for identifying and delineating the favorable zones for exploration artificial recharges.

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