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Suitable Site Detection for Groundwater Recharge in Parts of Shambhavi- Pavanje River Basin

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Abstract: ***The present study is the result of the research work carried out by generating the thematic maps based on satellite images and integrating the maps in a GIS environment, to suggest suitable locations/structures for artificial recharging of groundwater aquifers. Remote sensing (RS) data provides synoptic view, repetitive coverage and multispectral information, can be used successfully to generate different thematic maps. The study area covers about 355sq.km, which includes part of Shambhavi and Pavanje River basins of Mangalore, Karnataka. The area lies between 13^{0}00' and 13^{0}08' North latitude and 74^{0}45' and 75^0 00' East longitudes. SOI topographical map, satellite images of IRS-IC LISS III data, and Google images were used in the present study. ERDAS 2013 and Arc Map 10 software's have been used to generate and integrate various thematic maps. Structures like nala bunds, check dams are suggested for recharging aquifers.***

Keywords: RS, GIS, ERDAS, thematic maps, artificial recharge

1. Introduction

Water is essential for all life forms and is used in different ways such as food production, drinking, domestic, industrial, power generation and recreational use. Water is finite resource and cannot be duplicated and produced on commercial scale. Worlds total water resource is of 1460m.cub.km, oceans and seas of 94%, ice and glaciers of 2%, ground water and soil moisture is of 4%, surface rivers, lakes negligible. Only 2.7% of the water on earth is fresh of which only 1% is available for human consumption. According to World Bank report [1] India will be in water stress zone by the year 2025 and water scare zone by 2050.

In a progressive society it is natural that demands of water remain on the rise. In this context the issue are varied and complex in our country, because in India there is remarkable variation in the availability of water on account of the regional and geography. Further the increasing population and urbanization are having telling effect on the availability and quality of water. In this situation the activity of artificial recharge to ground water is an indispensable measure which is substantially beneficial, as this will help to store the surplus rainwater in the form of ground water and in turn arrest the decline of water level and degradation of the quality. All the same it is eco friendly. Burrough, P.A., 1990 [2], Dhruvanarayana and Sastry (1986) [3], Karla (2005) [4], Thakur and Raghuwanshi (2008) [6] have reported the success stories of rain water harvesting.

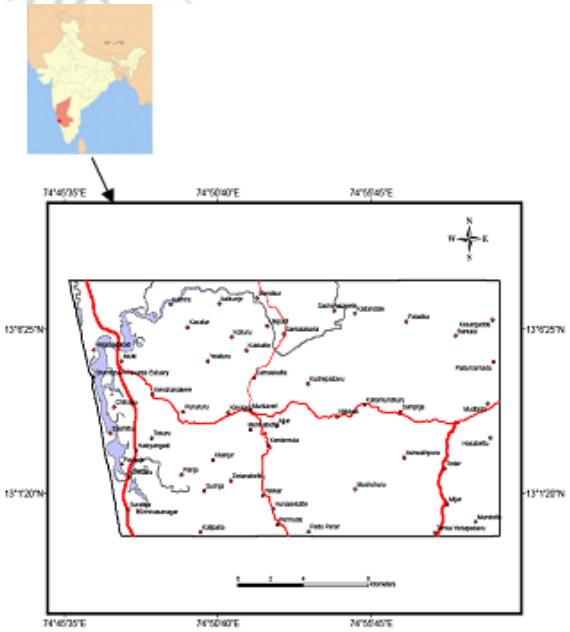

Figure 1: Location Map of the Study Area

2. Description of Study Area

The area falls along the west coast of peninsular India and is separated from the rest of peninsula by Western Ghats. The area lies between 13^{0}00' and 13^{0}08' North latitude and 74^{0}45' and 75^0 00' East longitudes, and marked in the Survey of India topographical map number 48K/16, which covers an area of 355sq.km. It is part of Dakshina Kannada district of Karnataka. The highest point is at the height of 240m from the mean sea level. The major rivers in this area are Pavanje river and Shambhavi river. The average rainfall of this area is 3,609mm.

3. Materials and Methods

The thematic maps such as contour, slope, road network, drainage, drainage frequency, land use/land cover, geology,

geomorphology etc. are necessary for the detection of suitable sites for artificial groundwater recharge. These maps were generated using-

1. Survey of India Topographical map-48 K/16.
2. IRS-1C LISS III satellite imagery.
3. Geological map
4. Google images
5. ERDAS 2013
6. ArcMap 10

Georectification of the topographical map was first carried out using ERDAS IMAGINE 2013. Thematic maps were prepared from SOI topographical map. Updated geological map has been prepared from Geological Survey of India map as a base. Geomorphological and Land use/land cover maps were prepared using LISS III and Google images. TIN, slope, aspect, hill shade maps were also created using 3D-Analyst extension where the contour values are taken into account. These maps were prepared using Arc GIS software.

4. Results and Discussion

1. Geology Map

The map prepared by using Geological Survey of India, Geological map. The area consists of coastal sands, laterite, dolerite, biotite hornblend granite, banded biotite gneiss and charnockite.

2. Lineaments Map

Lineaments are defined as linear or curvy linear features of geological importance. The lineament intersection areas are considered as good groundwater potential zones. Lineaments provide the pathways for groundwater movement and are hydrogeologically very important (Sankar, 2002) [5]. Lineaments have been identified based on the visual analysis of the satellite images. 25m area on either side of lineaments and intersection of lineaments are considered to be favourable for accumulation of groundwater. Most of the lineaments in the study area are in NW-SE and NE-SW direction.

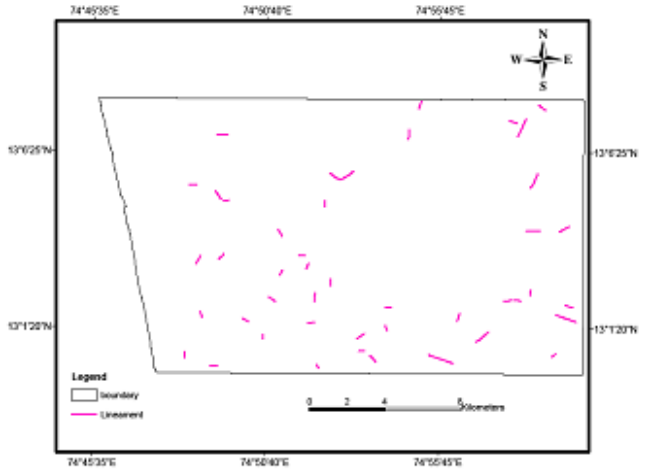

Figure 2: Lineament Map

3. Geomorphology

3.1. Drainage Map: The drainage map has been prepared by digitizing the topographical map using Arc Map. Strahler's method is used for ordering the streams. Pavanje and Shambhavi rivers originate in the midlands, at altitudes of about 140m and 160m respectively. The number of first order streams present in this area are 536, second order are 195, third are 65, fourth order are 7 and there are 2 fifth order streams. The drainage patterns seen in the area are- Dendritic, radial, parallel, rectangular, deranged and meandering.

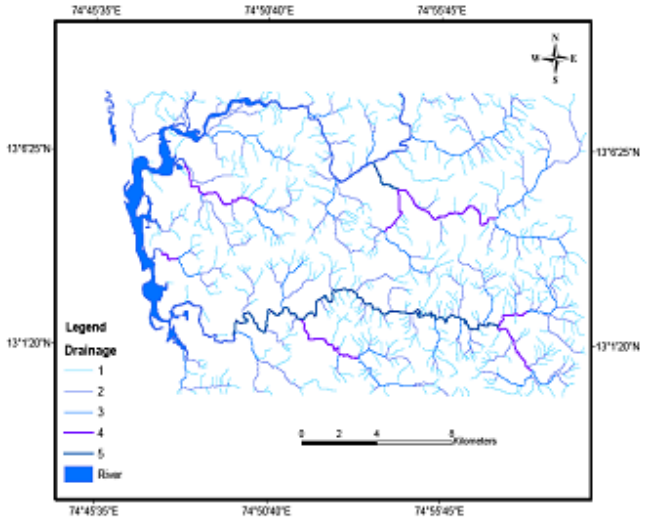

Figure 3: Drainage Map

3.2. Drainage Frequency Map: Drainage frequency is defined as number of streams per unit area. The spatial map showing the drainage frequency has been generated using drainage map shown in Figure 3. In the coastal plain, drainage density and drainage frequency are controlled by lithology, slope and infiltration capacity. Drainage frequency values of the study area ranges from 0.25 to 6.5.

3.3. Slope: To prepare a slope map contour values are necessary. This map is prepared using Survey of India topographical map and contours are digitized using Arc Map and attributes i.e. elevations are given. A TIN is constructed by triangulating a set of vertices. Wentworth's method is used for the generation of slope.

3.4. Landforms: The area under investigation is a region of comparatively low relief. Morphological details have been extracted from the IRS IC LISS III image and topographical map. A detailed geomorphologic map of the area has been generated and the details of the landforms identified are Marine/Coastal land forms-Beach, spit, estuary, tidal flats, Fluvial land forms- Alluvial plains, point bars, channel bars, Denudational land forms- Pediplain, colluviums, mesa, rock exposures.

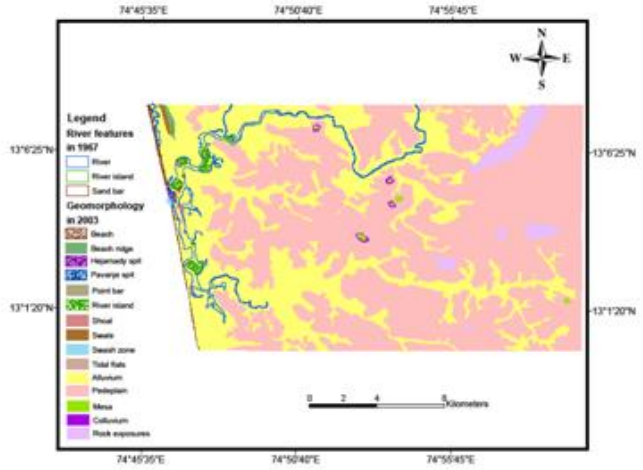

Figure 4: Integrated map of Geomorphology, river

3.5. Land Use/Land Cover: Knowledge of land use and land cover is important for many planning and management activities and is considered as essential element for modeling and understanding the earth as a system. The basic USGS land use and land cover classification system is used to classify landuse/land cover.

Table 1: Land use/Land cover Classification

Level I	Level II
1 Urban or built-up land	11 Residential
	12 Commercial and service
	13 Industrial
	16 Mixed urban or built-up land
2 Agricultural land	21 Crop land and pasture
4 Forest land	41 Deciduous forest land
	43 Mixed forest land
5 Water	51 Streams and canals
	54 Bay and estuaries
7 Barren land	72 Beaches
	74 Bare exposed rock
	75 Strip mines, quarries and gravel pits

A groundwater recharge well was constructed in the study area near S. Kodi, Kinnigoli. According to local people, the structure was constructed about 30 years back under a scheme of "Krishi Bhoomi Neeraavari Yojane" by Talipady Gram Panchayat. The diameter of the well is about 50ft and the depth is about 5ft. A check dam was constructed near Sankalakaria to the Sankalakaria River, which joins the Shambhavi River. The water stored due to the construction of this check dam will solve the water problem of many neighboring villages. A well is also dug by the Panchayat; the water from this well is supplied to the villages. Nala bunds were constructed to the small streams near Kateel, the water stored in these are used for irrigation as well as for domestic purposes.

Various thematic layers are integrated using ArcGIS for the detection of suitable sites for artificial recharge. Weightage assigned for all the classes is 20. Each sub class has given ranks 1, 2, 3, 4 and 5. Score is given by multiplying the weightage with rank. i.e., when rank is 3 then the score is 60. Status of groundwater is given as very poor, poor, moderate, good and excellent based on scores 20, 40, 60, 80 and 100 respectively.

As shown in Figure 4 Geomorphology and river maps were integrated and the areas having alluvial plains with less drainage i.e., drainage frequency less than 1.25 are considered as excellent groundwater recharge site, Pediplains showing drainage frequency of 1.5 to 2.5 are considered as good. Lateritic mesas with moderate drainage frequency are considered as moderate sites for recharge and the area having hard rock without any structures having very high drainage frequency are considered as very poor sites. Geology, river and drainage and lineament maps were integrated using Arc Map software to delineate some suitable sites for groundwater recharge. The major rock types seen in this area are granites, gneisses, laterites and coastal sands. Coastal sands are considered as excellent sites for recharge but the construction of any recharge sites is difficult because of loose sands. Weathered laterites are good, but the lateritic duricrusts are poor because of their hardness. Gneisses with joints and fractures are moderate sites for artificial recharge or else these are very poor sites for recharge of groundwater because of their massiveness.

Table 2: Ranks for Various Classes

Class	*Rank*	*Score*	*Groundwater recharge status*	*Rank*
Geomorphology	Alluvial plains	5	100	Excellent
	Beach sands	4	80	Good
	Pediplain	3	60	Moderate
	Lateritic mesa	3	60	Moderate
	Duricrust	2	40	Poor
	Rock exposures	1	20	Very poor
	Agricultural land	5	100	Excellent
	Mines and quarries	3	60	Moderate
	Residential	2	40	Poor
	Mixed urban	1	20	Very poor
	Forest land	2	40	Poor
	Bare rock with fractures and joints	3	60	Moderate
	Bare rock without fractures and joints	1	20	Very poor
Lineament		5	100	Excellent
Slope	$1\text{-}3^0$	5	100	Excellent
	$4\text{-}9^0$	4	80	Good
	$10\text{-}24^0$	3	60	Moderate
	$24\text{-}63^0$	2	40	Poor
	$>63^0$	1	20	Very poor
Geology	Alluvium (coastal sands and river courses)	5	100	Excellent
	Laterite	4	80	Good
	Banded biotite gneiss with joints	3	60	Moderate
	Dolerite	2	40	Poor
	Charnockite	1	20	Very poor
Drainage frequency	0-1.25	5	100	Excellent
	1.25-2.5	4	80	Good
	2.5-3.75	3	60	Moderate
	3.75-5.0	2	40	Poor
	>5.0	1	20	Very poor
Geomorphology	Alluvial plains	5	100	Excellent
	Beach sands	4	80	Good
	Pediplain	3	60	Moderate
	Lateritic mesa	3	60	Moderate
	Duricrust	2	40	Poor
	Rock exposures	1	20	Very poor

Land use/land cover	Agricultural land	5	100	Excellent
	Mines and quarries	3	60	Moderate
	Residential	2	40	Poor
	Mixed urban	1	20	Very poor
	Forest land	2	40	Poor

Nirkere show meandering trend for a considerable distance, hence more area (river course) will be available for storing the water. In built up areas like Mulki, Mudabidri and Kinnigoli Roof top rain water harvesting is suggested. The rain water available from roof tops of buildings areas goes waste. This water can be harvested for two purposes- first one is the water is stored in containers or tanks above or below the ground surface and the second purpose is recharging the water into the ground for augmenting the ground water.

The old lateritic quarries can be used to recharge ground water. The large amount of rain water can be stored in this and allowed it to percolate into the ground. For this the channels must be constructed and the surrounding water must be allowed to flow to these quarries.

The rain water stored in granitic quarries can be used for various purposes like domestic, irrigation etc. When there are no joints or fractures the water can be stored for long time. In Aikala the water stored in the granitic gneiss quarry is being used for domestic purposes by the workers staying over there. Even in the late summer there is sufficient amount of water.

References

[1] Anonymous (2002) World Bank Report on
[2] Burrough, P.A., (1990). "Principles of GIS for Land Resource Assessment." Oxford Science Publication, Oxford. Water Resources.
[3] Dhruvanarayana, V. V., & Satry, G., (1986) "Design of earth dams for water harvesting and erosion control in Shivaliks." Journal of the Institution of the Engineers (India), Civil Engineering. 67 pp 110-114.
[4] Karla, B. S., (2005), "Making of rain water harvesting movement in Saurashtra, Gujarath, India- A case study." Abstracts of national conference on watershed management of sustainable production live hood and environmental security (WAMSP 2005) held at G.B. Pant University of Agriculture and Technology, Pantnagar, Uttaranchal from May 19-21, pp 67.
[5] Thakur, G. S., and Raghuwanshi, R. S., (2008), "Perspect and assessment of ground water resources using Remote Sensing techniques in and round Choral River basin, Indore and Khargone districts, M.P." Journal of Indian Society of Remote Sensing. 36 pp 217-225, 2008.
[6] Sankar K (2002) Evaluation of groundwater potential zones using Remote Sensing data in upper Vaigai River Basin, Tamil Nadu, India. Journal of the Indian Society of Remote Sensing. 30(3) pp 119-129, 2002.

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