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Identification of Appropriate Location for Artificial Groundwater Recharging using Geospatial Technique in Bilaspur District

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***Abstract*—Groundwater is a precious resource of limited extend. However over exploitation has depleted groundwater availability. The increased demand for water has increased awareness towards the use of artificial recharge. The lack of effective groundwater recharge structures in a region usually brings about adverse effect on groundwater utilization. Bilha block of Bilaspur district comes under semi-critical stage of ground water development. Looking to the need of groundwater recharge plan for this district a study on groundwater recharge planning was carried out in the Department of Soil and Water Engineering, Faculty of Agricultural Engineering, IGKV, Raipur. Various thematic maps including District and Block boundaries, drainage, slope, soil texture, lineaments, geology and water level depth were generated in the environment of GIS. Satellite image IRS P6 LISS III, was classified using supervised classification method to generated Landuse map of the area. The total geographical area of the district is 554151 ha in which 42.65% (236210.5 ha) is available for agriculture. The geology map has been also be generated there are find total five formation. The upper, middle and lower reaches of drainage lines were considered for different sizes of check dam. Finally 179 locations were identified for check dams, whereas 147 locations were identified for percolation tanks in Bilaspur district**

Keywords: Ground water, Recharge Structure, Drainage, Lineament, Land use, Land cover

1. INTRODUCTION

Water has become a scare resource all over the world. Water resource of earth can be classified as surface water and ground water source. The total volume of ground water is only 0.65% of the total water availability of the globe [1]. Ground water is one of the important natural resource of the earth which is required for drinking, irrigation, industrialization etc [2]. In order to ensure a sensible use of ground water its proper evaluation and management is required. Its availability depends upon presence of rock types and their properties such as porosity, permeability, transmissibility and storage capacity. Scarcity of ground water depends upon the development activities of the area. Continuous failure of rainfall, increasing demand and overexploitation of ground water also cause to depletion of ground water. These problems could be sorted out to certain extents by artificial recharge to the aquifers by construction of small water harvesting structures across streams/watersheds. When the natural recharge rate is not sufficient to maintain the demand for water, the balance is disturbed and hence require for artificial recharge. The main objective of artificial recharge is to provide sustainability to ground water by restoring supplies to aquifers depleted due to excessive draft and to enhance recharge to the aquifers lacking adequate natural recharge both in space and time. In hard rock terrains, groundwater availability is of limited extent. Occurrence and movement of groundwater in such rocks is generated and checked with adequate field data, particularly well inventory and yield data.

2. MATERIALS AND METHODS

2.1 Study Area

Bilaspur is the district headquarters and is 120 km away from the state capital Raipur. Only one block of Bilaspur district of Chhattisgarh is semi-critical as per published by CGWB, NCCR, Raipur. Bilaspur district is located between 81°14' to 82°15' E longitude and 21°47' to 23°08 'N latitude and covers an area of 6377 km^2. The average altitude of the Bilaspur district is about 262 m above mean sea level (MSL). The district is bounded by Korea on the north, Anuppur and Dindori District of Madhya Pradesh state on the West, Kawardha on the southwest, Durg and Raipur on the south and Korba and Janjgir-Champa District on the East.

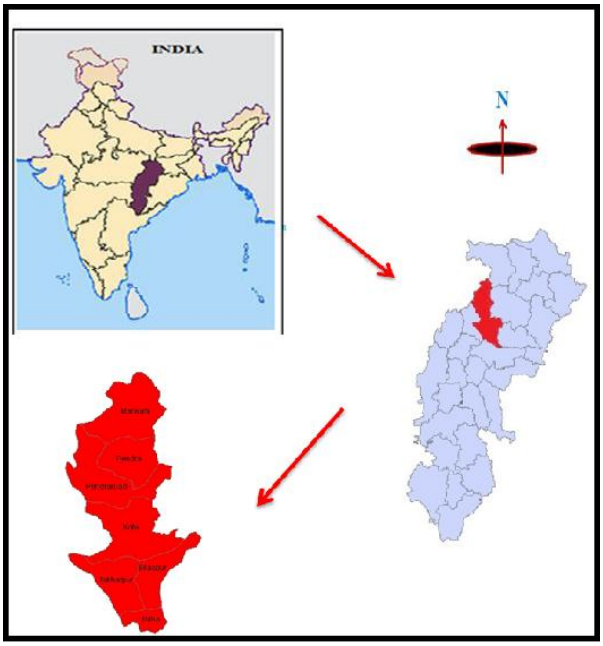

Fig. 1: Location of the study area in India and Chhattisgarh

Satellite image for the Bilaspur district was procured from National Remote Sensing Centre (NRSC), Hyderabad. The description of satellite data used in the study is given in Table 1.

Table 1: Detail of satellite image used in this study

Satellite/ Sensor	Resolu-tion (m)	Path	Row	Date of Pass	Spectral resolution
IRS-P6/ LISS III	23.5	102	056	15-Nov-2014	Band-2: 0.52-0.59µm Band-3:0.62-0.68 µm Band-4:0.77-0.86 µm Band-5:1.55-1.70 µm

Hydrogeological data were collected from the Central Ground Water Board, (CGWB), NCCR and Raipur. Thematic maps including depth to water level (per monsoon), depth to water level (post monsoon) were also acquired from Central Ground Water Board NCCR, Raipur. Drainage and water bodies map was prepared with the help of topographic map and ArcMap 10.0 GIS software. Watershed map was collected from State Water Resource Department, Government of Chhattisgarh which was further rectified in the environment of GIS.

3. RESULTS AND DISCUSSION

3.1 Geology Map

The digitized geology map of Bilaspur is shown in Fig 3, which indicates that the geology of the study area has varied formations. Bilaspur district has four major formation viz. BGC, Gneiss, Limestone, Sandstone and Shale. The geology information, lithology and area occupied by the different formation are given in Table. 2

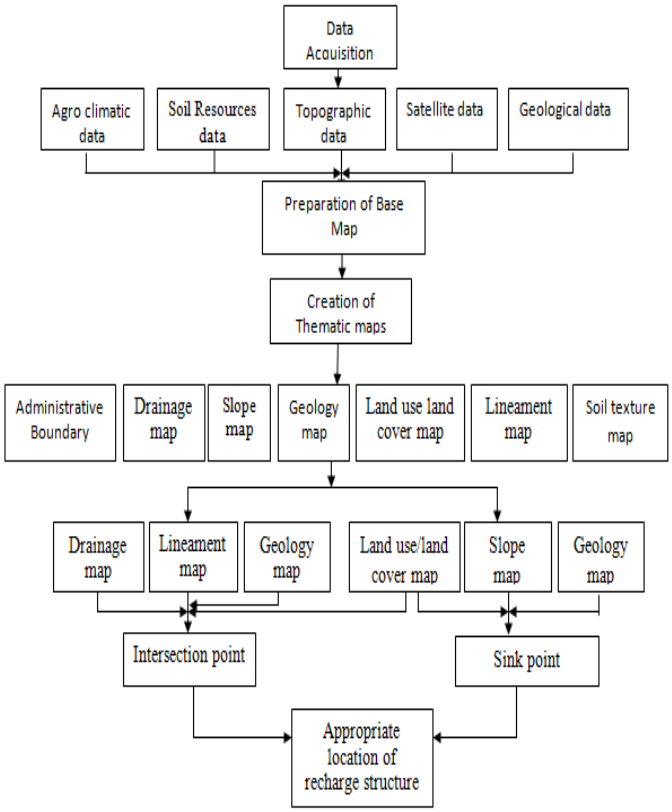

Fig. 2: Flow chart showing methodology

. Table 2: Geology Formation of the Bilaspur District

S. No	Types of Formation	Area in km^2
1	BGC	2759.37
2	Gneiss	323.13
3	Limestone	1812.5
4	Sandstone	279.16
5	Shale	363.39

3.2 Soil Texture Map

Soil texture map of the Bilaspur district is shown in Fig. 4 which was prepared through GIS using available soil resource data of the area. The area occupied by the soil texture identified in the study areas are given in Table 3 respectively for Bilaspur district.

Table 3: Area under different soil texture prevailing in the Bilaspur district

S. No	Soil name	Area in km^2	% Total area
1	Clayey	292.04	5.28
2	Coarse loamy	102.73	1.85
3	Course/ fine loamy	1.85	0.03
4	Fine	1557.38	28.18
5	Fine Silty	1103.56	20.04
6	Loamy Skeletal	131.62	2.38
7	Fine Loamy	1289.86	23.34

3.3 Lineament map

The lineament map was prepared and mentioned in Fig. 5. Lineaments are the linear, rectilinear, curvilinear features of tectonic origin observed in satellite data. These lineaments normally show tonal, textural, soil tonal, relief, drainage and vegetation linearity and curvilinerities in satellite data. All these linear features were interpreted from the satellite data and the lineament map of the study area was prepared.

Table 4: Lineament map of the Bilaspur District

S. No.	Block	Length (km)
1	Bilha	59.44
2	Kota	308.90
3	Masturi	442.14
4	Marwahi	243.71
5	Pendra	368.93
6	Pendra Road	574.22
7	Bilasrpur	136.65
8	Takhatpur	146.96
	Total	2387.65

3.4 Drainage map of the Bilaspur district

Drainage map was prepared by using Survey of India Topographic maps on 1:50,000. Drainage map was prepared by using Survey of India Topographic maps on 1:50,000. All the streams existing in this district are marked in Fig 6, The Mahanadi River drains about 90% of the area in the district and the rest is by the Ganges River. The Major tributaries of Mahanadi are Seonath, Maghdhara, Sukhad, Jaswa, Sagar, Teswa, Agar, Maniari, Chhotinarmada, Gongha, Arpa, Khurung and Lilagar. Son is the major tributary to the Ganges.

3.5 Land use/land cover map of the Bilaspur district

Land use/ land cover map was shown is shown in Fig. 7. Satellite image was procured from NRSC Hyderabad. This satellite image was classified in the ERDAS IMAGINE 10.0 using supervised classification method or more commonly known as pixel based classification method. Eight classes were identified out of which agricultural land was found to occupy 42.65% of the total geographical area. The Table 5 present shows area under different land use classes in the Bilaspur district.

Table 5: Area under different land use classes in the Bilaspur district

S. No	Description	Area in ha	Area in (%)
1	Agricultural land	236210.5	42.65
2	Current Fallow	36254.17	6.54
3	Barren land	3729.16	5.54
4	Settlement	124494.5	22.47
5	Forest cover	10904.7	18.23
6	Deep water body	4994.0	0.90
7	Shallow water body	897.3	0.16

3.6 Digital elevation model (DEM)

Digital elevation model was generated using the contour map along with the field surveys done using Global Positioning System. The elevation of the project area is found to be in the range of 214 to 1136 in above mean sea level. The DEM was generated by the classifying the relief in six classes. The slope map play major role in delineating the farming situation for preparation of site specific management plan.

The highest elevation recorded in the district is 1136 m above MSL and lowest point is 214 m above MSL.

3.7 Suitable location for artificial recharging

The entire thematic map was overlapped to get the appropriate location for constructions of structures for artificial groundwater recharge. The structures identified were check dam over nala's stream and others lines whereas percolation tank of varying sizes were proposed to intercept the overland flow. Lineament as the rock fractured was considered to be one of the important factors along the geology strata in locating appropriate sites for permit water to enter the groundwater. Intersection point of drain land and lineament were classified suitable for construction of check dams. Which fall in the proximity of agricultural low land so as to make efficient use of the constructed structure. Likewise, sink point were considered in conjunction to the lineament and geology map for the construction of percolation tanks. Two sizes viz small and medium percolation tanks were suggested for agricultural upland and agricultural low land respectively. A total of 179 sites for check dam and 147 numbers of percolation tanks were purposed for Bilaspur district for artificial groundwater recharging.

4. CONCLUSION

Remote sensing Geographical Information system (GIS) approach is very constructive. The GIS technique is useful in spatial intersection of different land use and land cover with various hydrological soil groups in the study areas. All the thematic maps were converted into grid analyzed by weighted overlay method. Thematic map including drainage, geology, lineament, soil and slope maps were considered to identify the location of groundwater recharges structures. The suitable recharge sites were suggested accordingly for these districts. Overlaying of different thematic maps is shown in Fig.8. These zones are then compared with the Landuse/Landcover map and ordering of drainage for the further adopting the suitable structures for rain water harvesting/artificial recharge to the aquifer system in the particular structures. Overall total of 179 numbers of Check Dam (CD) and 147 numbers of Percolation Tank were indentified based on the above study.

5. REFRENCES

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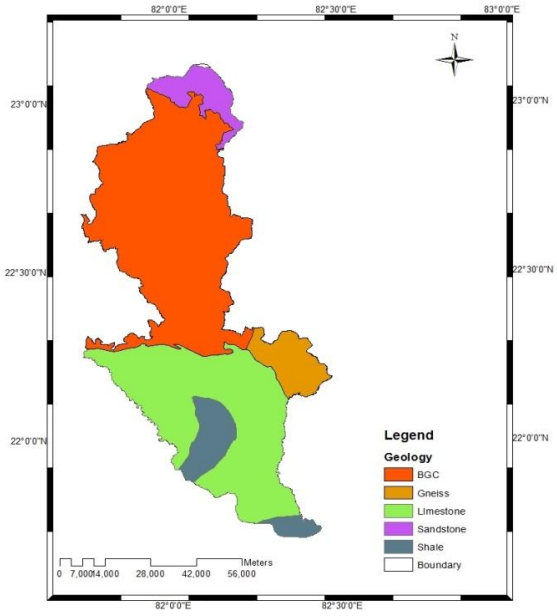

Fig. 3: Geology map of the Bilaspur district

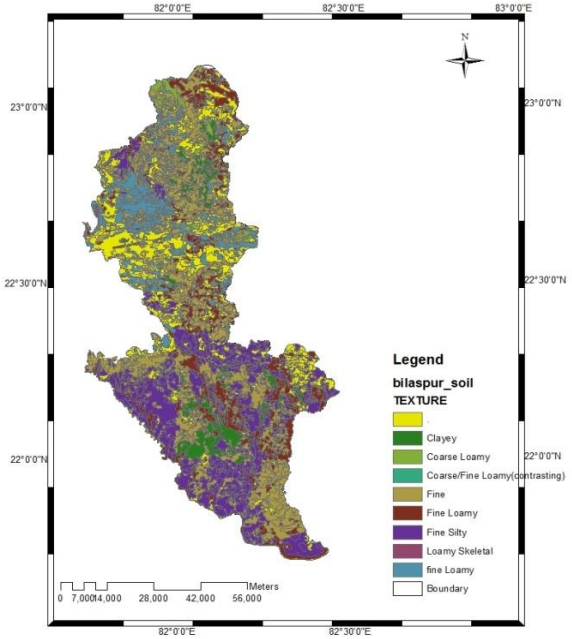

Fig. 4: Soil Texture map of the Bilaspur district

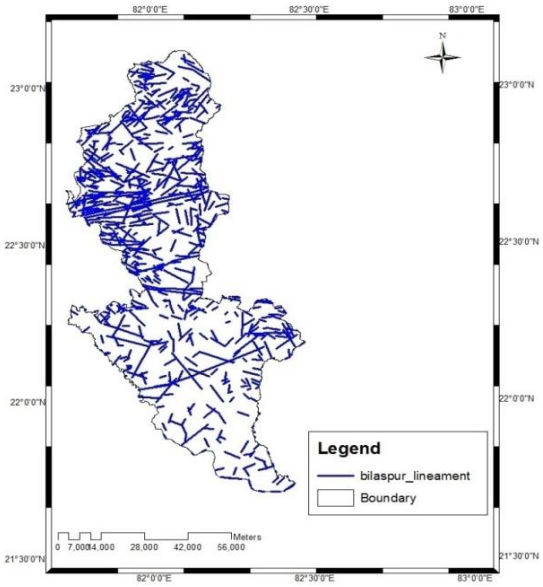

Fig. 5: Lineament map of the Bilaspur district

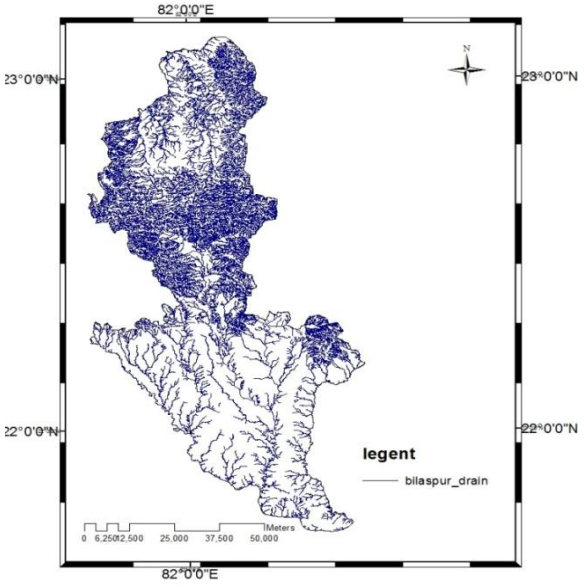

Fig. 6: Drainage map of the Bilaspur district

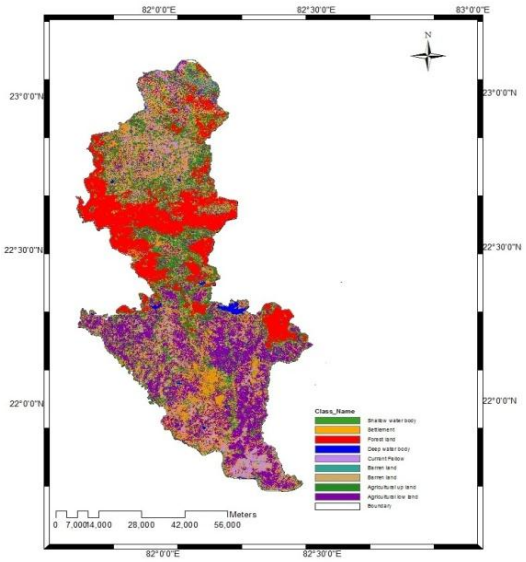

Fig. 7: Land use/cover map of Bilaspur district

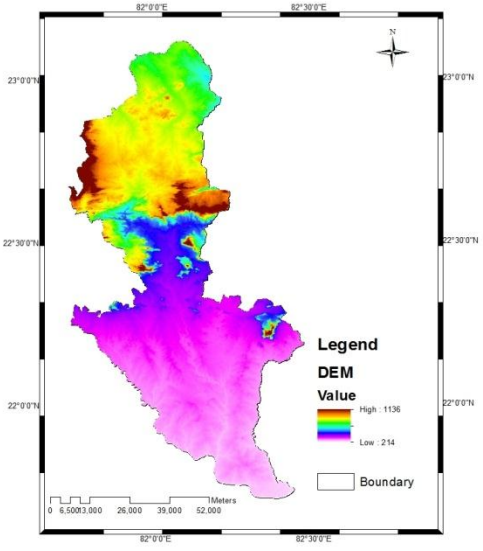

Fig. 8: Slope map of the Bilaspur district

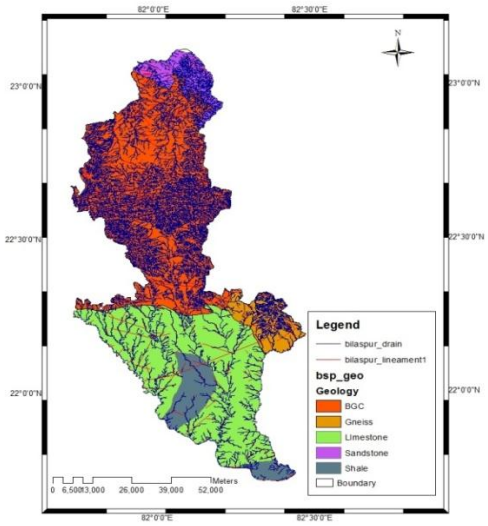

Fig. 8: Overlay of drainage, geology and lineament map of Bilaspur district

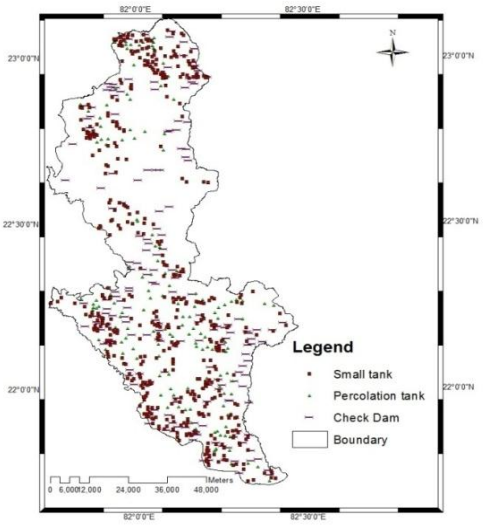

Fig.9: Identified site for groundwater recharge structures in Bilaspur district