Suresha and Jayashree, J Remote Sens GIS 2019, 8:3

Journal of Remote Sensing & GIS

ISSN: 2469-4134

Research Article

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Demarcation of Groundwater Potential Zones in Devalapura Sub Watershed Mysuru District Using Remote Sensing and GIS

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Received: October 18, 2019; **Accepted:** November 03, 2019; **Published:** November 11, 2019

Abstract

As the demand and needs of the population towards water is growing, the value of water is felt in all sectors. At the same time, because of less rainfall surface water resources are becoming insufficient to fulfill the water demand. There is a need of systematic planning of ground water improvement using modern techniques and there is a need to demarcate groundwater potential area for the proper management and utilization of water. Groundwater resources have not yet been properly exploited. Keeping this in view, the present study has been undertaken to delineate the ground water potential zone in Devalapura sub watershed area using RS and GIS approach. An integrated study using thematic maps of geology, geomorphology, soil, slope, land use/land cover and drainage density were used in the present study. Ground water potential zones have been demarcated by ARC GIS Software. Finally, four groundwater potential zones were delineated viz., very good, good, moderate and poor. From the present study it was concluded that, demarcation of groundwater potential zones are useful for effective recognition of suitable locations for extraction of ground water and better planning and management.

Keywords: Ground water; Remote sensing; GIS

Introduction

Groundwater is considered as one of the most basic and precious needs for the survival of mankind to fulfill our basic necessity of life. In our country more than 80% to 90% of the rural and 30% to 40% of the urban population depends on groundwater for drinking purpose, agriculture activities and industrial usages. Water scarcity due to exploitation of groundwater natural resources is common in different parts of India [1,2]. In major villages, town and cities in several part of our country peoples are facing serious problems related to depletion groundwater level [3]. In recent days, ground water levels are decreasing which has affected industries, agricultural activities, and urbanization. For these reasons, prepare management of groundwater has become a priority in the field of groundwater related research work.

For proper and better understanding of groundwater resource a comprehensive study combining, geological, structural, geomorphological and drainage pattern using GIS technique is essential. The main source of information about various surface features related to groundwater management in the use of Remote sensing and GIS techniques [4,5]. On the other hand GIS is a powerful tool for handling many spatial data and decision making by a wide range of uses such as hydrological and environmental parameters. Recently, many researchers have used remote sensing and GIS technique for the exploration of groundwater potential zone [6,7].

Proper planning and groundwater resource management are essential, because mining related activities can damages the groundwater aquifers and also reduced the groundwater recharge area. With the scarcity of surface water people are very much dependent on the groundwater resource. In this paper an integrated approach has been used to demarcate suitable groundwater recharge structures in the Devalapura sub watershed, using remote sensing and GIS techniques.

Methodology

Study area

Mysuru district lies between 12°07’05” and 12°27’13” North latitudes and 76°50’10” east longitudes, covering an area of 809.6 sqkm. There are four hoblie viz., Varuna, Jayapura, Kasaba, Ilavala in Mysuru district (Figure 1).

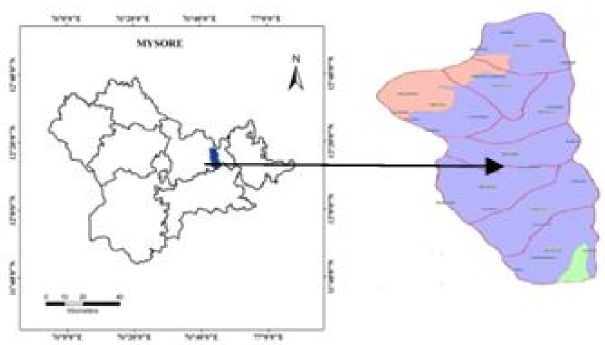

Figure 1: Location map of study Area.

The area of present investigation lies in the watershed 4B3C as codified by the National Institute for Soil Survey and Land Use Planning (NISS & LUP) and further classified as sub, mini and micro watersheds using classification made by KSRSAC (Figure 2). The study area is located in Mysuru district of Karnataka, state, covering an area of 280.43 km^2 and having lot of 12°.22’N and long 76°.42’E.

Citation: Suresha KJ, Jayashree TL (2019) Demarcation of Groundwater Potential Zones in Devalapura Sub Watershed Mysuru District Using Remote Sensing and GIS. J Remote Sens GIS 8: 267.

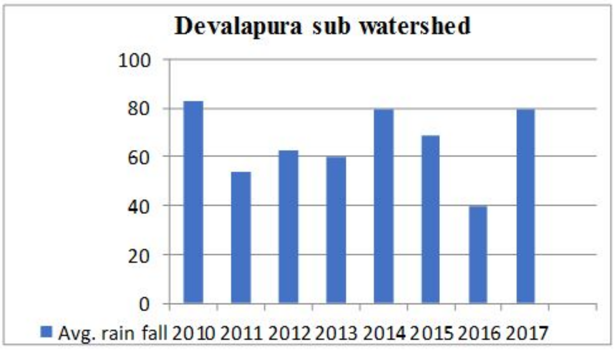

Figure 2: Rainfall distribution in devalapura area.

Results and Discussion

The research study is carried out with the help of four major components. It involves collection of data from satellite imageries, study of Toposheet, preparation of block maps and detailed usage of ancillary data. The satellite data are obtained by PAN and LISS from a specific source. Toposheet data are used as base map, which forms the background setting for a map. (obtained from Geological Survey of India). The features of the study area such as soil type slope of the area, rainfall data, geology and geomorphology is obtained by making interrelating thematic maps. These thematic maps are subjected to supervised classification and the attributes are generated for each map. These attributes are geo-referenced by TIN (Triangular Irregular Networks). Thematic maps generated in spatial analyst tools to obtain the final groundwater potential map. There are six important indicators namely, (i) geology, (ii) slope, (iii) geomorphology, (iv) land use/cover, (v) drainage and (vi) lineament for groundwater prospects. Preparation of maps for these themes (except slope) based on image characteristics such as tone, texture, shape, color and association are standardized. Slope is derived from 30 m resolution. Thematic maps of the study area were prepared (Figure 3 and Table 1).

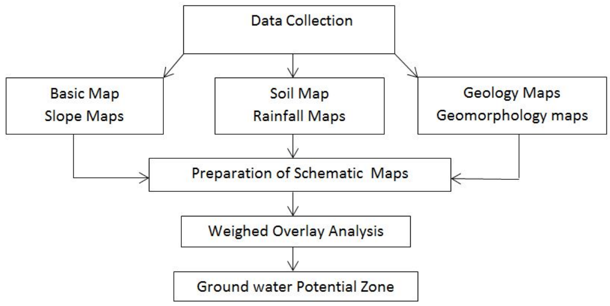

Figure 3: Flowchart for groundwater potential assessment using RS and GIS.

Suitable classes	**Land use**	**Area km^2**	**Area%**
Land use type of study area			
Very suitable	Water bodies	2.55	0.91
Suitable	Agricultural land	255.47	91.09
Moderate suitable	Forest and grass land	14.47	5.16
Unsuitable	Built up land	7.95	2.83
Suitable classes	Slope class%	Area km^2	Area%
Slope of the study area			
Very suitable	0-3	222.24	79.25
Suitable	Mar-15	40.58	14.47
Moderate suitable	15-35	9.01	3.21
Unsuitable	35-50	8.6	3.07
Suitable classes	**Drainage density**	**Area km^2**	**Area%**
Drainage density of history area			
Very suitable	0-1	189.6	67.61
Suitable	1-1.5	49.82	17.78
Moderate suitable	1.5-2	40.96	14.61
Suitable classes	**Soil type**	**Area km^2**	**Area%**

Soil type of the study area			
Very suitable	Sandy	53.8	19.18
Suitable	Loamy	147.3	52.53
Moderate suitable	Fine	65.63	23.41
Unsuitable	Fine loamy	13.6	4.88
Suitable classes	**Lithology**	**Area km^2**	**Area%**
Lithology of study area			
Very suitable	Amphibolitic metapelitic	3.9	1.39
Suitable	Schist	13.49	4.82
Moderate suitable	Chamundi granite, Magnatite and grano diorite	263.04	43.79

Table 1: Study Chart.

Thematic map layers

Road network map: The base map is prepared for each Study area using the survey of India topographical map scale 1:50000 and the Satellite data. The base details such as hobli, panchayath, boundaries, roads, railways, and river/stream and settlement locations are extracted from the topo maps. Multi-date IRS geocoded satellite data (which includes PAN+LISS and quick bird) is used for interpretation and for the preparation of wasteland maps. After the preliminary interpretation, the various wasteland categories are interpreted and delineated based on tone, texture, shape, pattern, association, location, etc. using on screen digitization. The interpreted maps are verified through ground verification and modified accordingly. Based on the field information the map is finalized.

Drainage map: Area investigated has parallel to sub parallel drainage pattern. Drainages are less dense study area and most of the natural drainage lines are encroached by formers and real estate/ builders, thus creating artificial drainage adjacent to parcels level for the inconvenience of water supply for the crops in canal command area. Tanks are small in rain-fed area and they are not full throughout the year. Some of the tanks are full throughout the year, due to canal connected to tank (Figure 4).

Lithology map

Geologically, the district is mainly composed of igneous and metamorphic rocks of geologically, the district is mainly composed of igneous and metamorphic rocks of Pre-Cambrian age, either exposed at the surface or covered with a thin mantle of residual and transported soils. The rock formation in the district falls into two groups, charnockite series and granite gneiss and gneissic complex. Pegmatite veins and dolerite dykes are common in the district and this as a bearing on the tectonic history of the area as well. Prominent lineament is seen in the area which oriented in a NNE-SSW direction, N-S as well as NW-SE direction. The foliation in the granitic gneiss is trending NE-SW to NNW-SSE with an easterly dip of 400 to 800. Faults are observed trending E-W to NW-SE. near Mysore city a big granite batholiths is seen and is known as Chamundi granite (Figure 5).

Lineament map

Lineament plays important role in groundwater exploration. Lineaments are linear to curvilinear features with influence of geological features like deep-seated fracture and it is a subsurface phenomenon. Lineaments can trace out on satellite imageries while observing the following criteria:

- An alignment of dark or light tone
- Elongated patterns of native vegetation
- Between two lithological contact gneiss and granites etc.

The groundwater prospects are good to very good depending on the nature and intensity of lineaments. It is well understood that, the hard rock terrains are devoid of primary porosity and the distribution and movement of ground water depends on the interconnected fractures systems. Devalapura of fractures in hard rock's is generally due to tectonic activity. Some of these fractures are filled with water or it is be a dry fracture at shallow levels. Some of the deep seated fractures, which are filled by water also followed by the water bodies like streams, river etc. Interaction of two lineaments, are good source for groundwater prospective zones. In the study areas, interlaced by major and minor lineaments which vary in length from a few meter to kilometers in dimension have been recorded (Figure 6).

Soil map

The soil map shows different soil series and phases like clayey, clayey over sandy, fine, habitation mask, and loamy skeletal. The soil map was prepared using remote sensing techniques and satellite imagery of 1:12500 scales. A physiography map was prepared using the information of SOI toposheets, geology, slope maps and image characteristics. Pedants were studied in the field for each physiographic unit. The soils were classified using the USDA system of classification upto series level. The soil mapping unit is at the level of series and its phases which include the surface stoniness, rockiness, salinity/sodicity, drainage impedance, erosion status. Based on the relationship of physiography with soil, the physiography map was converted to a soil map (Figure 7).

Land use/Land cover

Land use land cover maps can be prepared using both visual and digital interpretation techniques. As far as interpretation is concerned, visual techniques are more realistic than digital

In visual interpretation different land use classes can be identified and classified based on the image interpretation elements viz. Tone, color, pattern, association, shape, shade, location and site. In case of digital interpretation, classification is done either supervise or unsupervised (Figure 8).

Slope map

Slope is the rate of change of elevation and considered as the principal factor of the Imperfection water flow since it determines the gravity effect on the water movement. The slope is directly proportional to runoff and groundwater recharge will be lesser in the areas with steep slope. The water flow over the gently undulating plains is slow and adequate time is available to enhance the infiltration rate of water to the underlying fractured aquifer which was obtained from contour or topo map. The identification slope category (in percentage) were classified into category wise and listed in table (Figure 9).

Geomorphology map

The major geomorphic units in the study are Pedi plain, pediments and hills. The terrain is undulating to flat. The slope is towards east and north direction. The geomorphological units are further subdivided into Pedi plain, deeply weathered under canal commend moderately weathered under canal commend, shallow weathered under canal commend and the gullied area. The rest of the area in the Pedi plain is moderately weathered Pedi plain. The mounds and rolling lands are runoff zones are called pediments and larger area is covered by hills (Figure 10).

Ground water prospect map

The occurrence and movements of ground water in hard rock terrain are controlled by numbers of factors such as lithology, structures, geomorphology and thickness of land forms, soil types, land use, land cover and major one recharge of rainwater. Expect rain fall data, other aspects have been generated using satellite data qualitatively on regional scale. Such information derived from satellite data integrated with adequately hydrological and collateral data will be useful in the delineation of groundwater prospect zones. It is well understood that there exists a close relationship between landforms lithology. Structure and availability of water resources. Information on landform is one of the important aspects for land and water resource managements. Apart from the land form, the geological information and structure also play an important role in identification of groundwater potential zones. Groundwater prospects are excellent along the fractures and under tank and canal commend areas. Slightly good to moderate in the pediplain areas under seasonal canal commend. Slightly good to moderate to poor in pediplain shallow of rainfed area and poor in pediments zone (Figure 11).

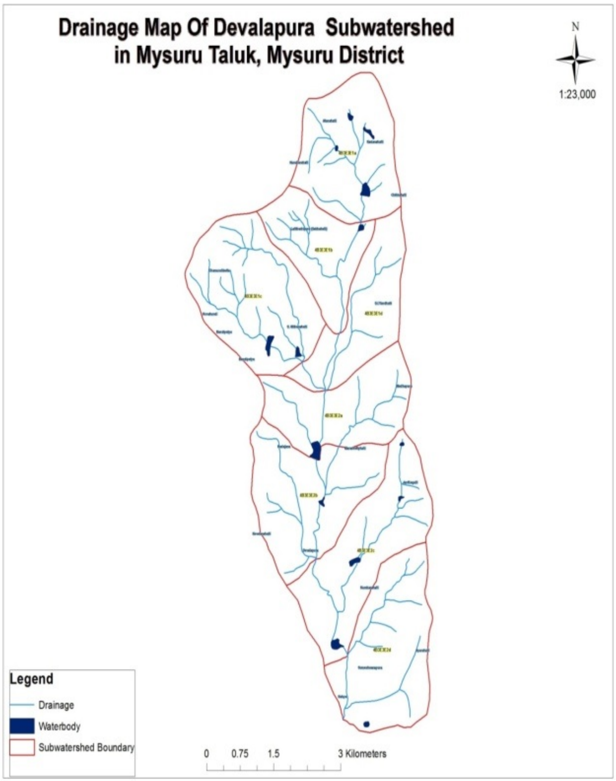

Figure 4: Drainage map of Devalapura sub watershed.

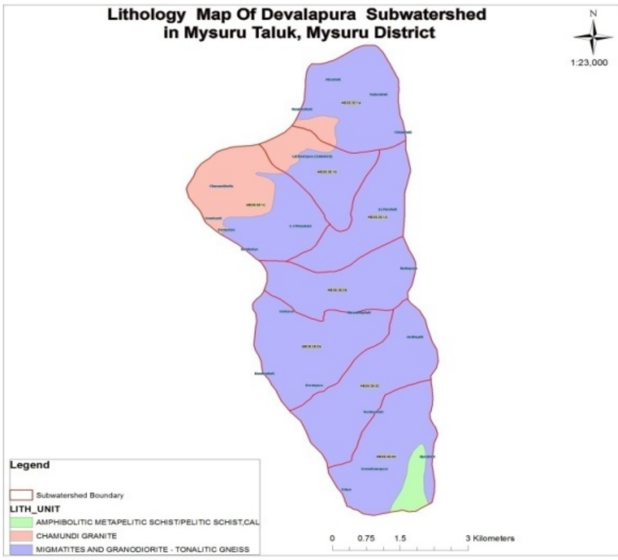

Figure 5: Geological map of Devalapura sub watershed.

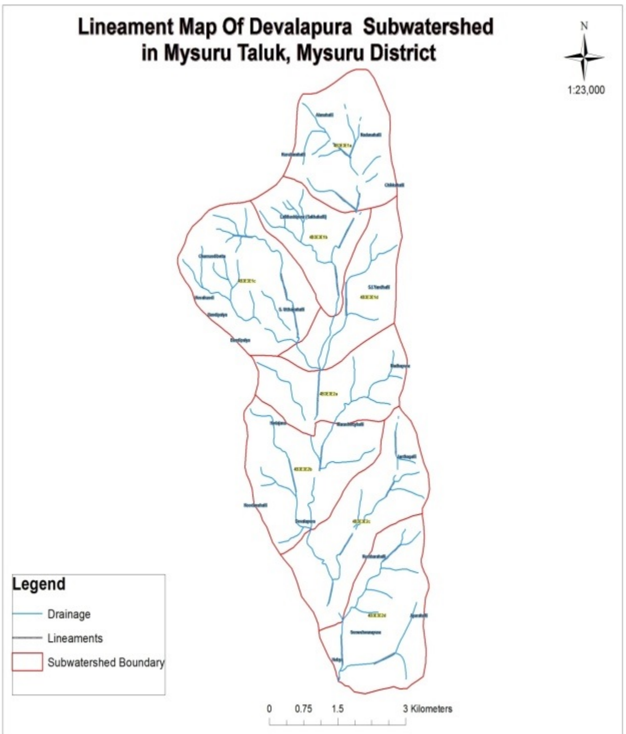

Figure 6: Lineament map of Devalapura sub watershed.

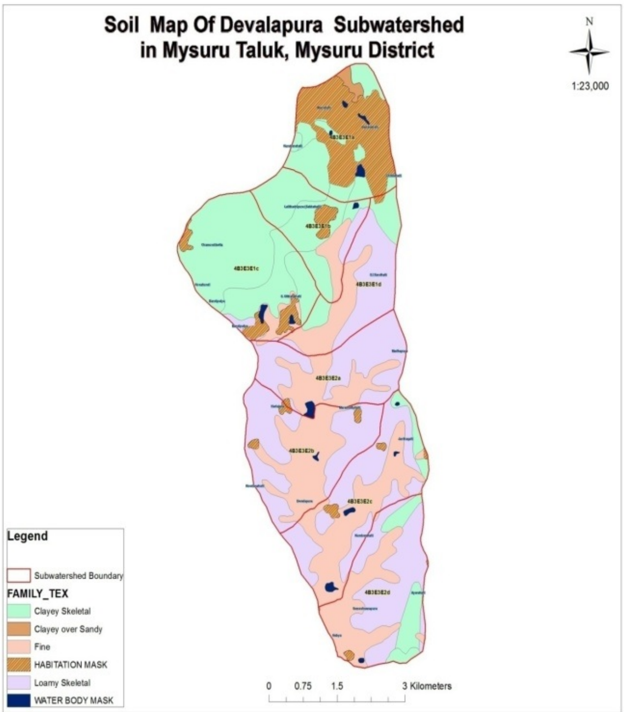

Figure 7: Soil map of Devalapura sub watershed.

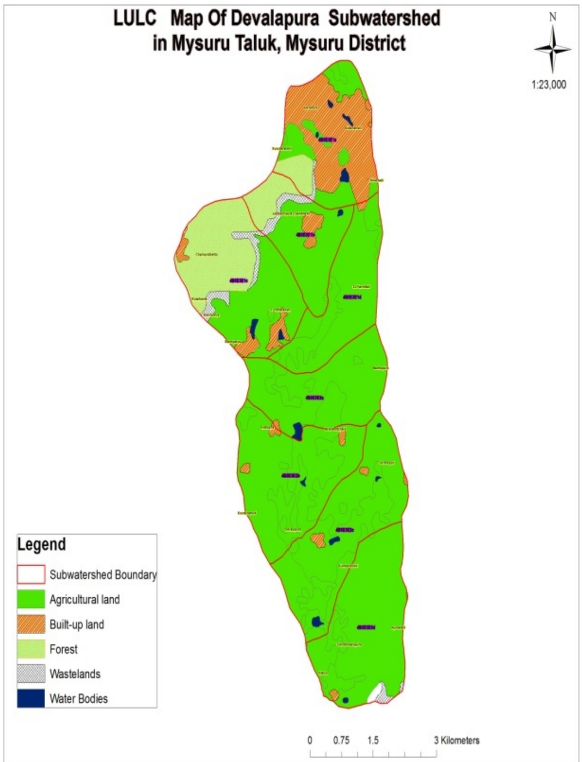

Figure 8: LULC map of Devalapura sub watershed.

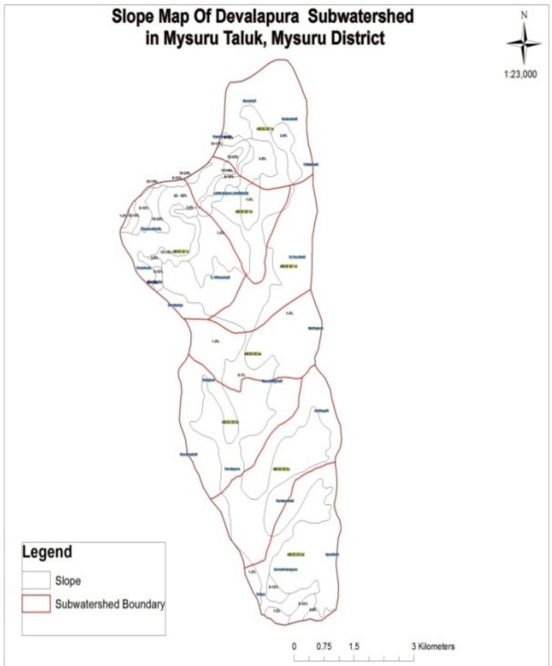

Figure 9: Slope map of Devalapura Sub watershed.

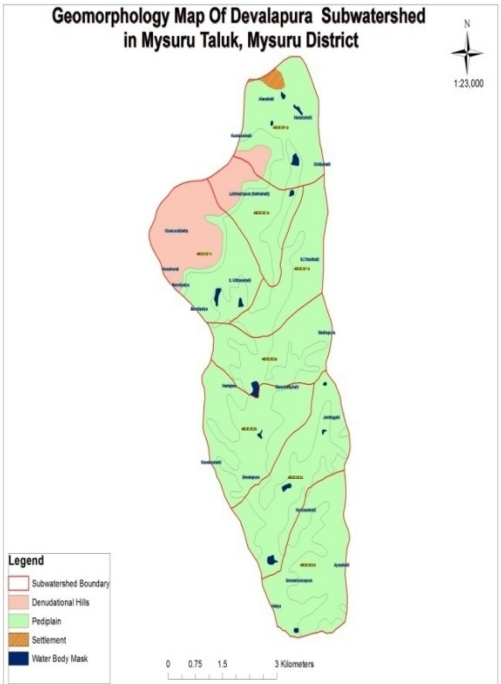

Figure 10: Geomorphology map of Devalapura Sub watershed.

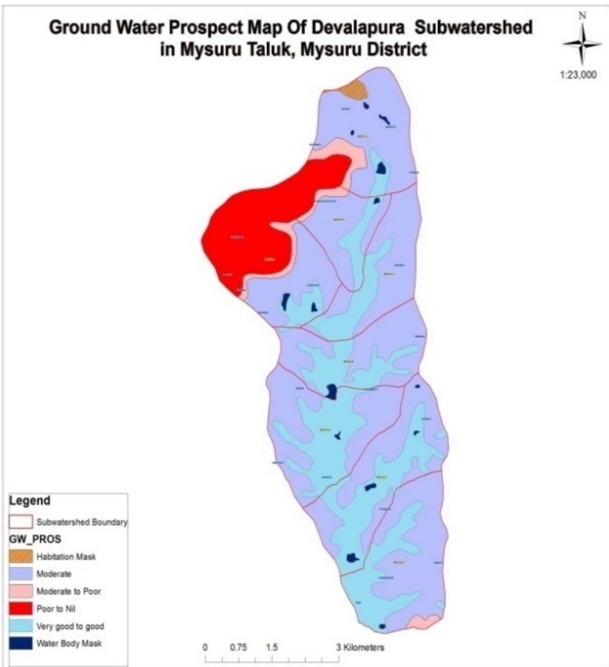

Figure 11: Ground water prospect map of Devalapura sub watershed.

Conclusion

Based on the results of the present study, the following conclusions have been drawn.

- The groundwater prospect map obtained contains moderate and very good to good potential regions covering an area.
- The moderate potential zone comprises of area having 1%-3%, which is gentle slopped. The loamy-skeletal soil forms the background.
- The very good to good potential zone of area having 0%-1%, which is nearly flat. The fine soil forms the background.
- In flat and gently slopped region, the surface runoff is slow and hence, allows more time for rainwater to percolate.
- The infiltration rate of loamy-skeletal soil and fine soil ranges between 1.2 mm/hr and 3.8 mm/hr.
- Check dams and vegetative checks can be constructed in areas having slope of 3%-5% in order to facilitate rainwater percolation and increase groundwater recharge capacity of the region.

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