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IDENTIFICATION OF PERCOLATION SPOT LOCATIONS FOR CHECK DAM CONSTRUCTION USING GIS FOR POONDI BLOCK

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Abstract - The cyclic process of water cycle without any interruptions is the promising factor that ensures the existence of living creatures; right from micro organisms to all the other living beings. But nowadays, that water cycle is disturbed due to the prevailing conditions of pollution in environment and thereby the scarcity arises. In the water cycle, rain water and ground water are considered important. Rainwater can be later collected as ground water and taken for our usage. But now, rainfall is highly insufficient thereby ground water level is decreasing. But it can be collected artificially by the construction of check dam at the water holing areas. Poondi is our study area where we found some shortage of water and now coming with a solution. The software used for this are QGIS and Arc GIS. In this paper, the usage of thematic layers of soil texture, soil infiltration, geology, geomorphology, land use land cover, rainfall, drainage and slope (Mohanavelu Senthilkumar et al., 2019) is done. After that, the percolation spots of Poondi is plotted and analysed using Weighted Overlay Analysis technique in Arc GIS and thus the appropriate area of construction of check dam is determined.

Keywords: QGIS, Arc GIS, water cycle, thematic layer, Weighted Overlay Analysis.

I. INTRODUCTION

Our globe faces several hindrances in the recent years because of shortage of water. So preservation of water is very much necessary for the living. Over population is also the reason for water shortage *i.e.*, at the highly populated area, demand of water is obviously more. Several natural happenings like global warming etc., may also act as a barrier for conservation. In order to put the full stop for this obstacle taking shape permanently, the water conservation process is becoming significant. But this process cannot be succeeded by the effect of one person (or) one community alone; it should take place as a global process as water shortage is a global issue. Here percolation is thus defined as the shift (or) flow of water from upper to lower surface of soil (or) in between permeable rock by gravity and capillary forces. This percolation play a role in recharging with water by lake, rivers etc. Recharging capacity varies in every place and therefore, identifying the potential contented percolation spots is the purpose of this project. This can be enabled by construction of check dams. Check dam is a minor dam built across a ditch, drainage, swale (or) channel etc. It lowers the velocity of flow of water and induces the permeation of water. This is done at our study area Poondi with the aid of GIS techniques.

II. OBJECTIVES

By providing the following objective, the purpose of the paper is inferred. They are,

- To acquire a thorough knowledge in GIS technique.
- To be proficient in locating check dams.
- To develop suitability map for the study area.
- To discover the percolation spots.

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III. SCOPE

The scope of this project is

- To make use of thematic layers.
- To inhibit erosion and make water usage productive.
- To survey water scarcity level.
- To determine the percolation spots.

IV. OVERVIEW OF OUR STUDY AREA- POONDI:

Poondi is a village at Tiruvallur district in the state of Tamil Nadu (Fig.1). It is stationed at the coordinate of 10°51°N 78°56°E. It rests on 42m above sea level. The time zone of Poondi is UTC +5:30(IST).The weather is tropical with an average temperature of 28.6° C. The month of May has a high temperature of 33.2°C and December month has lower temperature of 24.4° C. The annual precipitation is 1102 mm (43.4 inch). The geographical area of settlement is approximately 476.34 hectares. In order to benefit this much area and people residing in the area, the construction of check dam is predicted profitable.

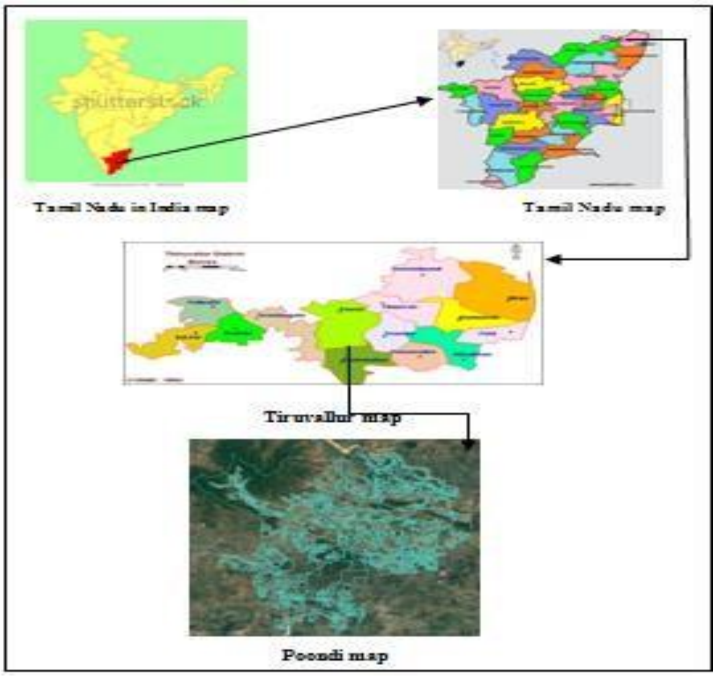

Fig.1 Key Whole Map

V. METHODOLOGY

There are several sources of data for input is detailed below:

- DEM data for SRTM data.
- Geology map from Geological survey of India.
- Geomorphology from Bhuvan, a national Geo-Portal developed and hosted by ISRO.
- Land use land cover map from Google satellite.
- Rainfall data from Indian Meterological Department (IMD).
- Soil texture and soil infiltration maps from. Tamil Nadu Agriculture University (TNAU).

These inputs have to undergo several processes like reclassification, digitization and analysis in the software Arc GIS. Finally, the three divisions of suitability- low, moderate and high is determined and at last the suitability map is developed.

The complete method adopted for obtaining the results is given briefly in a flow chart as methodology. Fig. 2 shows the methodology flow chart.

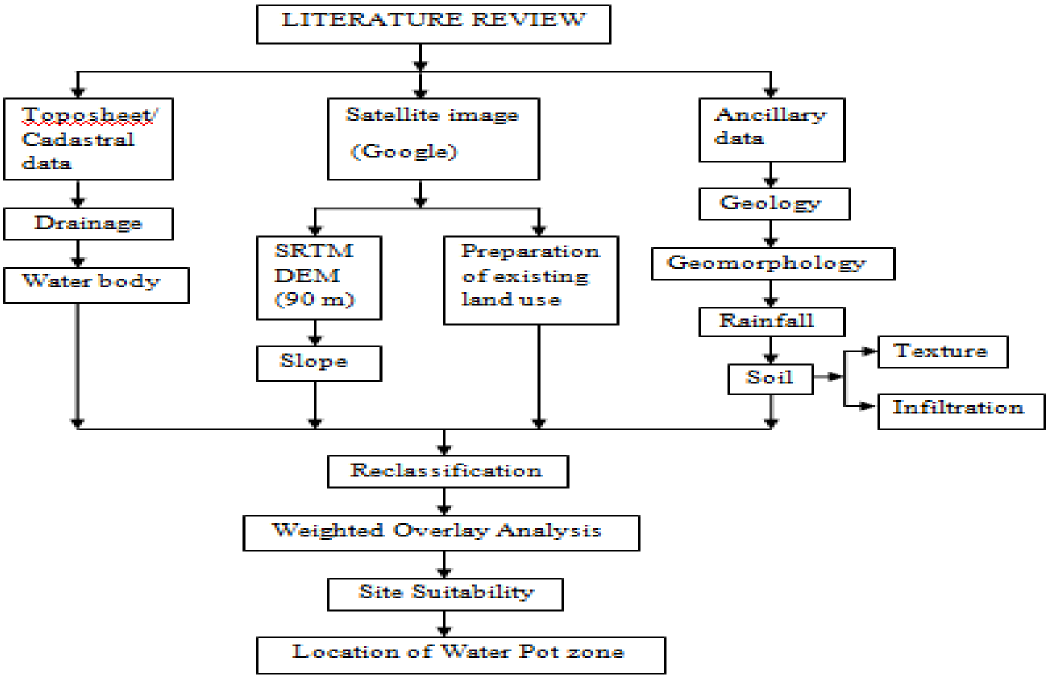

Fig. 2 Flow chart of Methodology

A. *Thematic Layers*

The conversion of codified layers of information to 'themes' using GIS technology is utilised by researchers and other users. Thematic data layers are information datasets that have a common characteristics (or) attribute placed in the same layer of spatial data. Moreover, it is also interpreted as "A spatial representation of analysed data of elements of the same type". These maps helps in displaying a categorical theme connected with certain geographical area such as variation in temperature, general reference maps also show a huge number of variable features like geological, geographical etc. Here there following categories are called as thematic layers which are provided as vector and raster datasets.

Vector Datasets: These datasets use points and lines for the representation of particular location. These layers are subjected to conversion into raster format in order to generate thematic layers.

- Soil texture
- Soil infiltration
- Geology
- Geomorphology
- Land use land cover
- Rainfall
- Drainage

Raster Datasets: These datasets use a set or series of cells for the representation of particular location.

- Slope

VI. Description of each layer

The list of complete layers are given as follows

- Soil texture and map
- Soil infiltration and map
- Land use land cover and map
- Rainfall and map
- Geology and map
- Drainage and map
- Geomorphology and map
- Slope and map

A. Soil Texture and map

Soil texture can be delineated to the proportion of sand, silt and clay sized particles that make up the mineral section of the soil. Texture of the soil is substantial because of its impact on the amount of the water that can be detained in the soil, the rate of water flow through the soil and the viability of the soil. Soil pattern often varies with depth. The texture of the soil can be discovered by quantitative and qualitative techniques. The most common method is being the hydrometer method, which is a quantitative procedure. The qualitative method is done by sensing the texture of the soil. In the study area the composition of soil are classification clay, clay loam, loams sand, sand, sandy clay, sandy clay loam, silty clay and urban settlement (Fig.3). The tests for soil pattern can be done at the field or the laboratory.

B. Soil Infiltration and map

Soil infiltration is the entry of water into the soil, which is measured in inches per hour. Infiltration permits the soil of preserve water, making it accessible to vegetation and soil organisms (Laura Lindsey *et al.,* 2018). The principal element affecting soil infiltration is soil texture. The lack of protective layer of plants leads to erosion of top soil which as a consequence fills the pores in the soil and averts infiltration. Soil infiltration range of Poondi differs from 0 to 9.34 (Fig.4).The components affecting soil infiltration are

- Precipitation
- Slope
- Soil attribute
- Soil moisture content
- Organic medium in soil
- Land cover

C. Land use Land cover and map

Land use is the characterization of land depending on what it can be used for and what can be put up on the land. It is determining what variety of needs. The most common land uses are recreational, transport, agriculture, residential and commercial (Diana Eastman community, environment or settlement can be utilized in a piece of land. Land use is the way they adjust that land to suit their, 2020).

Land cover is the surface cover on the earth like water, soil, vegetation, urban infrastructure (Copernicus Global Land Service). Land cover maps represent spatial information in different type of physical coverage of the Earth's surface.

The land use land cover of the study area comprises of drop crop, forest plantation, scrub forest, barren lake, towns, wet crops and land with scrubs (Fig.5).

D. Rainfall and map

Rain is the precipitation of liquid water with diameter greater than 0.5mm. Rain is a principal contributor to the water cycle. Rainfall varies from place to place, depending on the climatic conditions of the region. The rainfall pattern of our study area varies from 605mm to 1216mm (Fig. 6).

E. Geology and map

Geology also known as ‘Geo Science’ or ‘Earth Science’ is the study of the structure, advancement and vitality of the earth and its native mineral and energy resources, as well as looking at the forces that drive geological processes. It is a research about the history of the earth over the course of its 4.5 billion year existence. The examination of the rock record assists to trace the development and the consequent changes that take place on earth. The earth is basically composed of three types of rocks, name as igneous rocks, sedimentary and metamorphic rocks. Our region, Poondi is composed of rocks namely Gneiss, Basic rocks, Calcareous gritty sand stone, Laterite, Sand silt and sand stone (Fig. 7).

F. Drainage and map

The removal of surplus water either from the ground surface or from the root zone is known as drainage. Excess water is collected due to heavy rainfall or over irrigation. Drainage can be either natural or artificial. Natural drainage is where water flow and falls into rivers and lakes. But if natural drainage is not helping, the artificial drainage comes into play which is divided into surface drainage and subsurface drainage. The drainage of water for Poondi is classified broadly into first and sixth order as shown (Fig. 8).

G. Geomorphology and map

Geomorphology is the study of landform and their evolution (Stetler, 2014). It considers the factors that affect the earth surface processes such as air, water and ice landforms take shape by erosion or deposition, because of earth. Surface processes climate having a significant impact lead to the development of different land forms. Geomorphic incidents take place at a slow rate because of events such as volcanic eruptions, earthquakes, tsunamis etc. The land form of Poondi constitutes of alluvial plain, denudational hills, flood plain, structural hills, plains and many as portrayed in the map (Fig. 9).

H. Slope and map

The slope of land is a crucial geospatial parameter for any geographic study. The elevation difference between two points of a unit distance is referred to as slope (Balasubramanian, 2007). It is also referred to as gradient. Slope is represented in the form of percent slope or degree slope. The slope of the study area varies from 0 to 109.6 in degrees(Fig. 10).

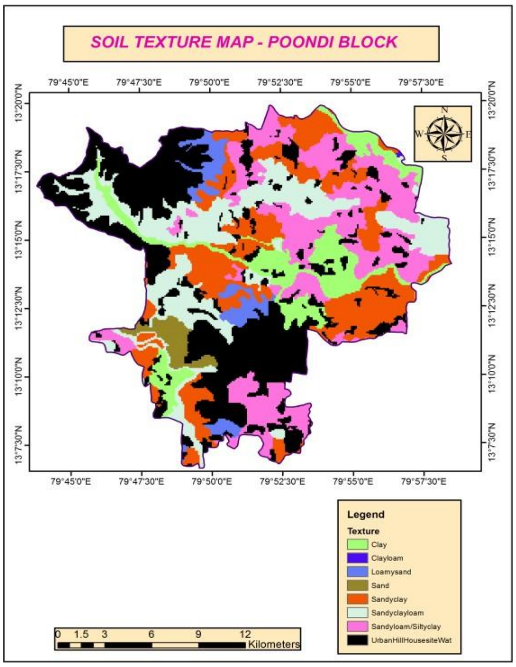

Fig 3 Soil texture Map

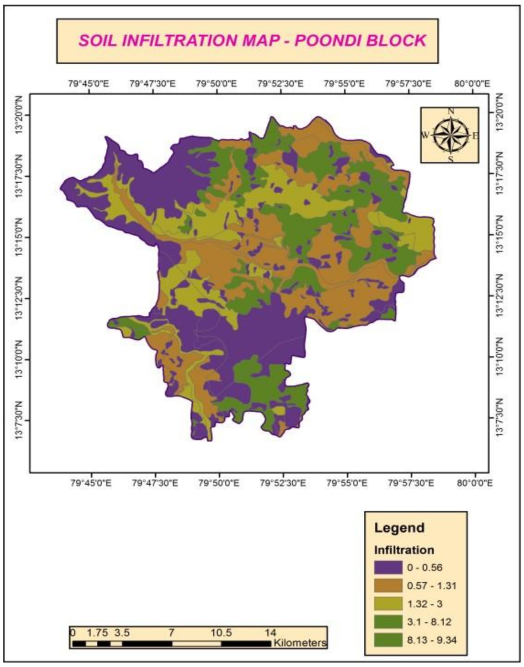

Fig. 4 Soil infiltration Map

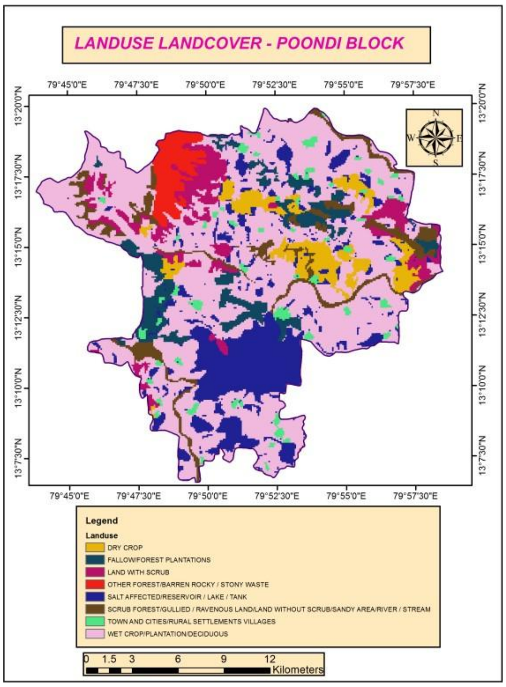

Fig. 5 Land use land cover map

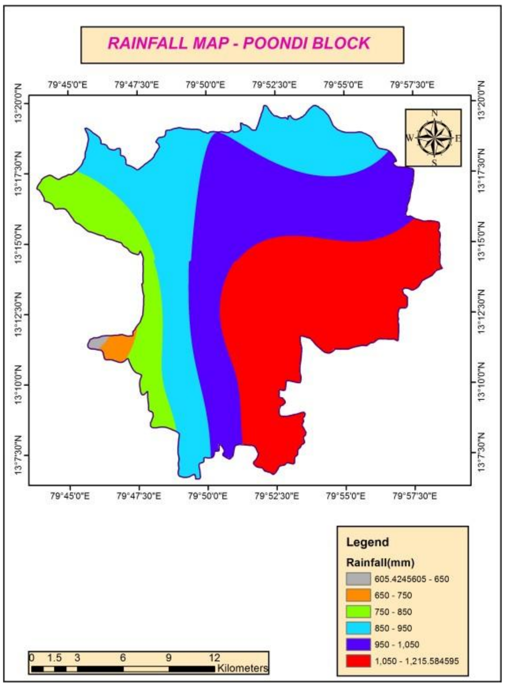

Fig. 6 Rainfall Map

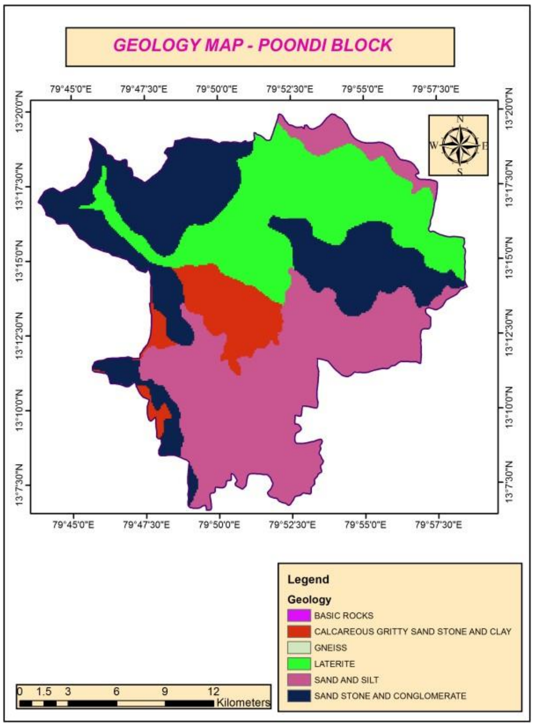

Fig. 7 Geology Map

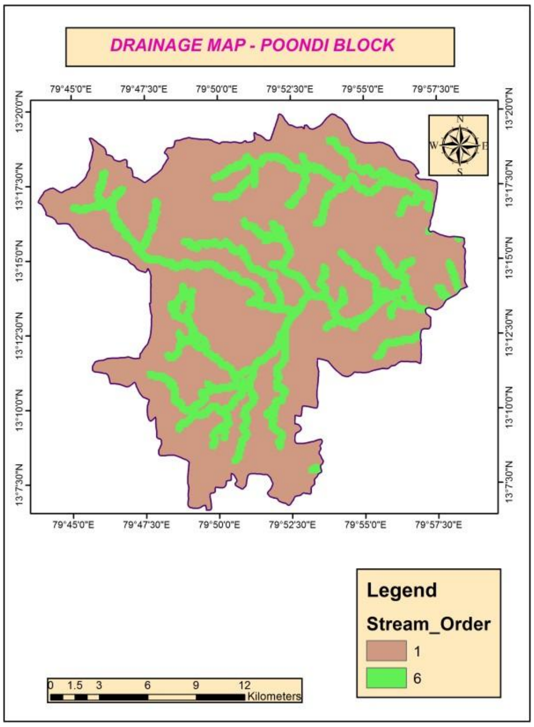

Fig. 8 Drainage Map

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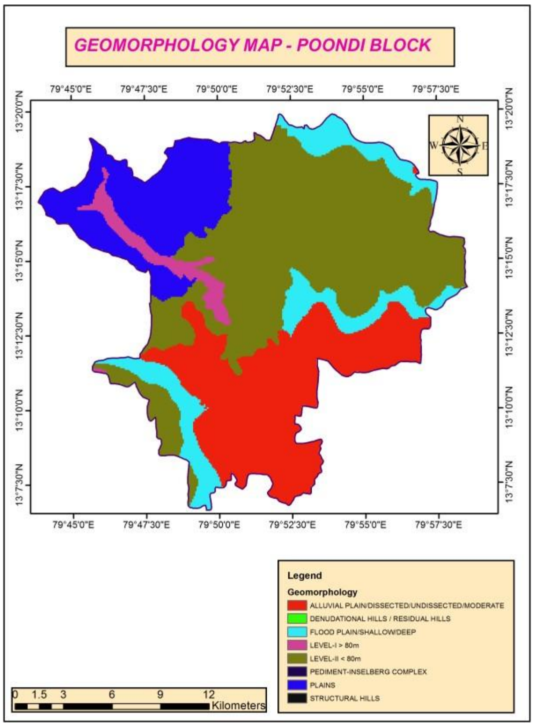

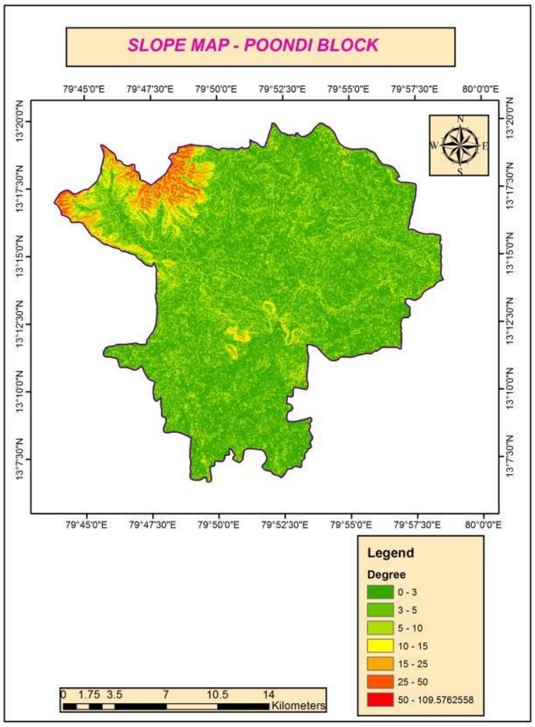

Fig. 9 Geomorphology Map **Fig. 10 Slope Map**

VII. ANALYSIS AND RESULTS

Before starting with analysis in Arc GIS, the input datasets except slope, all the other inputs must be converted to raster form *i.e.*, in the form of series of cells. Now, all the layers should be reclassified. The method is

Arc tool box → **Spatial analysis tool** → **Reclass** → **Reclassify**.

Now, the analysis can be done using the method of Weighted Overlay Analysis. As the word suggests, several different layers having different values and behavior are combined together to a common measurement scale and the layer can be given appropriate weightages. Weightages are allotted since there is no layer is of equal importance and some have higher impact on that particular area and some have lower impact.

Rank that ranges from 0-9 according to area of impact is also assigned. In our study area,'0' indicates less impact and '9' indicates high impact. This can be done inversely too. Now, weightages in integers are given, and therefore processed to obtain the output which is also in integers. While allotting weightages, the total cumulative frequency should be tallied to 100. Careful calculation is needed as the value should not be greater (or) lesser than 100. After processing, the suitability map (Fig. 11) is generated and it should be saved is the form of .tif (Raster file). The required weights and ranks are shown in Table 1.

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Table I Weightages and Ranks for Suitability Analysis

S.No.	Layers	Class	Ranks	Weighatge
1	SOIL TEXTURE	Urban hill	1	20
		Clay	2	
		Clay loam	3	
		Sandy clay	4	
		Sandy clay loam	5	
		Sandy loam	6	
		Loamy sand	7	
		Sand	8	
2	SOIL INFILTRATION	0 - 0.56	1	13
		0.57 - 1.31	2	
		1.32 - 3	4	
		3.1 - 8.12	7	
		8.13 - 9.34	9	
3	GEOLOGY	Basic rocks	1	10
		Gnesis	3	
		Calcareous	4	
		Sand stone	5	
		Laterite	6	
		Sand and silt	7	
4	GEOMORPHOLOGY	Structural hills	2	7
		Denudational hills	3	
		Plain	4	
		Alluvial plain	5	
		Flood plain	6	
		Level -1 > 80 m	7	
		Level -1 < 80 m	8	
		Pediment	9	
5	LAND USE LAND COVER	Town and cities	1	20
		Reservoirs	2	
		Barren rocks	3	
		Wet crops	4	
		Dry crop	5	
		Fallow forests	6	
		Scrub forests	7	
		Land with scrub	8	
6	RAINFALL	605 - 650	1	7
		650 -750	3	
		750 - 850	4	
		850 - 950	5	
		950 -1050	6	
		1050 - 1215	8	
7	DRAINAGE	Stream order 1	1	10
		Stream order 6	6	
8	SLOPE	0% - 3%	1	13
		3% - 5%	2	
		5% - 10%	3	
		10% -15%	4	
		15% - 25%	5	
		25% - 50%	6	
		50% - 109.58%	7	

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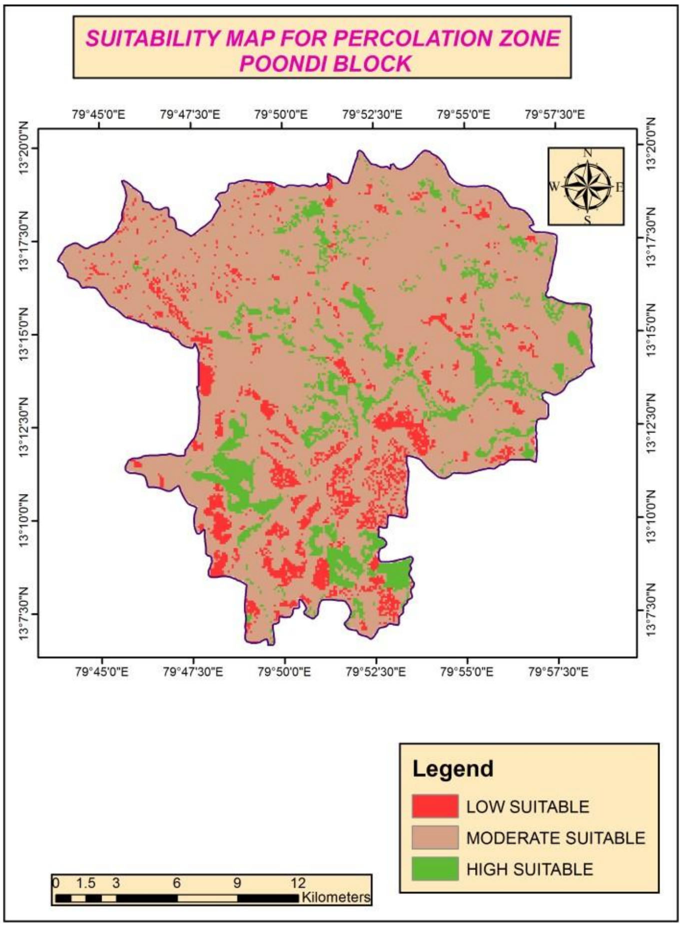

Fig. 11 Suitability Map for Percolation Zone

The result is thus acquired for Poondi which is categorized into three colours *viz.* red which denotes low suitability, dusky brown which denotes moderate suitability and green which denotes high suitability areas.

VIII. DISCUSSION AND CONCLUSION

Water scarcity is the escalating problem that can be dismissed. One among many ways of saving water is the building of check dams on the right places. These check dams act as a barrier which enables percolation of water into the ground and thus ground water recharge is done. In our study area, majority of places is highly suitable of percolation. Therefore, the check dam construction in these locations will be replenishing the ground water table. Moreover, GIS based work has proved to be economical and beneficial in a short period of time. These when done manually many leads to errors but not the precise results are obtained.

Hence, this research was carried out to highlight the importance of water management and conservation. Proposing one method for preservation with the help of GIS technology will influence more research work in this field. Thus, it can be concluded that,

- The percolation spots were recognized in Poondi with the use of GIS, thus signifying the importance of water.
- The influence of the check dam that has on soil erosion prevention and infiltration capacity is acknowledged.
- A thorough comprehension about that function of GIS application was obtained which increased the speed and ease of work.

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