International Journal of Emerging Technology and Advanced Engineering
Website: www.ijetae.com (ISSN 2250-2459, ISO 9001:2008 Certified Journal, Volume 6, Issue 9, September 2016)

A Comparative Study of Infiltration Rate at Selected Sites on Dosalavanka River Basin

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***Abstract*— Groundwater is very important as it supplies springs, and much of the water in our ponds, marshland, swamps, streams, rivers and bays. Estimation of groundwater recharge is a key challenge for determining sustainable groundwater development and management, especially in arid and semi-arid areas, where rainfall as well as recharge is neglible /low while evapotranspiration is high. Precipitation is the principal source for groundwater recharge. Different land use/covers such as Agriculture, Plantation, Residential and Barren lands were indentified and selected in the Dosalavanka river basin, Chandragiri Mandal, Chittoor district, Andhra Pradesh. In the present study the constant infiltration rates of different soil conditions carried out using double ring infiltrometer. From the obtained results it is observed that the residential areas are having low infiltration rates when compared with other areas. It is observed that the high infiltration rates for agricultural land in Sanambatla, for plantation in Thurakapalli and Pichinaidupalli. The present study will be useful for the groundwater recharge and estimation.**

***Keywords*—Double ring infiltrometer; Groundwater; Infiltration rate.**

I. INTRODUCTION

The infiltration rate is vital to the irrigation engineers as it influences the application rate of irrigation. [2], [6], [13] It is intricate to design an irrigation system without proper knowledge of infiltration characteristics of different soil. [5], [11], [12]. In dry-land agricultural infiltration characteristics will also be required for proper water management. It is useful for determination of availability of water for plants, runoff rate and percolation. Accurate determination of infiltration rates is essential for reliable prediction of surface runoff. [1], [7], [9] This is useful for mitigation of hydrological risk. The infiltration capacity of soil influences the occurrence of overland flow.

Most of the coastal regions are experiencing water related problems such as acute shortage of water, decline trend in water level and saltwater intrusion. Groundwater resource is becoming scarce, as is evidenced by the increasing demand on water, improper planning, poor agricultural practices, inefficient utilization, groundwater mining, peculiar soil characteristics, and steep slopes [16]

Moreover, soil compaction affects the physical properties of soil by increasing its strength and bulk density, decreasing its porosity, and forcing a smaller distribution of pore sizes within the soil.

These changes affect the way in which air and water move through the soil and the ability of roots to grow in the soil [8 & 3]. It is widely accepted that urbanization results in an increase in the area of land covered by impervious surfaces. This impervious surfaces results in an increase in storm water runoff which may lead to pollution in the form of soil erosion (suspended solids) and other contaminants such as nitrogen, phosphorus, and heavy metals being transported uncontrolled through the environment [4]. Implicitly, impervious surfaces reduce infiltration into the soil and decrease groundwater recharge, while increasing storm water runoff volumes and flow rates, potentially causing downstream flooding. Increased storm water runoff volumes can cause significant reductions in downstream water quality [5].

Estimation of groundwater recharge is a key challenge for determining sustainable groundwater development and management, especially in arid and semi-arid areas, where rainfall as well as recharge is low while evapotranspiration is high. Numerous studies have focused on groundwater recharge in Southern Africa over the past three decades [14].

Therefore groundwater level fluctuations are due to nature of the soil and type of material used for the construction of wells. Few wells are made up of using cement concrete walls in which the water level rise only during the monsoon season than remaining seasons. The source for groundwater recharge is only bottom of the well. Therefore, there is less chance to rise the water level in these type of well [16].

[17] studied the effect of meteorological parameters such as temperature, relative humidity, evaporation and rainfall on groundwater level fluctuation for Dakshina Kannada coastal aquifer at southwest coast of India.

II. DESCRIPTION OF THE STUDY AREA

Dosalavanka region in Chittoor district of Andhra Pradesh state was selected for the study, having latitude of 13°34'N and longitude of 79°22'E with an extent are of 150 Sq.km. Based on different land use/cover such as Agriculture, Plantation, Residential and Barren lands were indentified and selected in the Dosalavanka river basin, Chandragiri Mandal, Chittoor district, Andhra Pradesh. To understand the behaviour of soil infiltration tests were carried out using double ring infiltrometer.

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The water source in the study area is high and more number of bore wells are located near the study region. The location map of the study area are shown in Figure.1 and the details are presented in Table.1

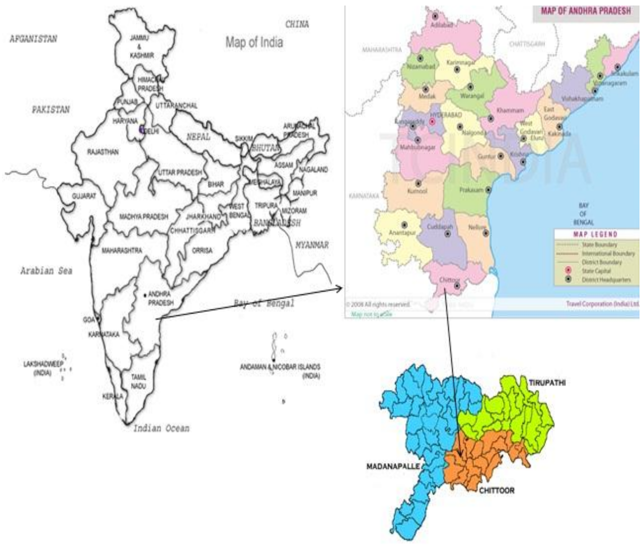

Figure.1 Location map of the study area

Table1:
Locations of different points where the test has been conducted.

Sl	Village name	Type of land	Latitude	Longitude
1	Sanam batla	Agriculture	13°34’50’’N	79°21’09’’E
		Plantation	13°36’45’’N	79°19’13’’E
		Residential	13°34’56’’N	79°20’05’’E
		Barren	13°34’28’’N	79°21’16’’E
2	Thurak apalli	Agriculture	13°34’54’’N	79°20’35’’E
		Plantation	13°34’36’’N	79°20’26’’E
		Residential	13°34’44’’N	79°20’16’’E
		Barren	13°34’42’’N	79°20’26’’E
3	Pichina idupalli	Agriculture	13°34’21’’N	79°19’57’’E
		Plantation	13°33’12’’N	79°18’55’’E
		Residential	13°34’31’’N	79°19’55’’E
		Barren	13°34’16’’N	79°19’54’’E

III. METHODOLOGY

Double ring infiltrometer

Double ring infiltrometer method was used for measurement of infiltration rates at all the four sites in the present study area. In this two concentric rings were used with 25cm deep, and diameter of 30cm for inner ring and 60cm for outer ring. The rings were driven at about 15cm deep in soil by using falling weight type hammer striking on a wooden plank placed on top of ring uniformly without disturbance to soil surface or minimal disturbance to the soil surface.

Water was poured into the rings to maintain depth of 7 to 12 cm and the quantity of water was added to maintain this depth at regular time interval of 5, 10, 20, 30 min. up to getting a constant infiltration rate. The observations for infiltration rate were carried out on inner ring with field type point gauge and stop watch etc. Simple double ring infiltrometer is shown in Figure.2

Figure.2. Simple Double Ring Infiltrometer

IV. RESULTS AND DISCUSSION

The infiltration depth at the selected time intervals was measured in all the land covers based on double-ring infiltrometer field observations. Total twelve experiments were conducted, each four at Sanambatla, Thurakapalli and Pichinaidupalli villages. The infiltration curves were plotted against infiltration rate versus time separately for each land cover.

From Figure.3, it is observed that a high infiltration rate occurs for agricultural land and low infiltration rates for residential areas due to abstractions and having less open lands for infiltration process. The infiltration rates are different for different land use /cover areas and it was observed that initially infiltration rates were higher and decreased with time up to steady infiltration rate.

In general, the decrease in infiltration rate will result in increased runoff volume, greater flooding potential and reduced groundwater recharge within watersheds. Compaction is also one of the important parameter which plays a vital role in infiltration process. Moreover, the ccompacted soils due to movement of agricultural machines have a low infiltration rate which is prone to runoff generation. It has a significant influence on soil hydraulic properties such as soil water retention, soil water diffusivity, unsaturated hydraulic conductivity and saturated hydraulic conductivity [15]. These hydraulic properties in turn govern infiltration rates.

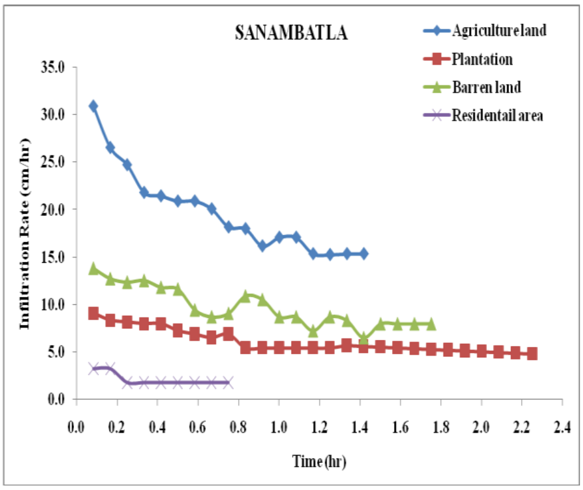

Figure.3 Infiltration capacity curve for sanambatla village

The Infiltration capacity curve for Thurakapalli village is shown in Figure.4 and it is observed that a high infiltration rate occurs for plantation land and low infiltration rates for barren land. The non-cultivation of land for a long time and having hard soils which results less voids spaces for the infiltration process. A decrease in infiltration rate wills results high surface runoff.

The barren lands are used for playgrounds, occasional village meetings, parking and movement of heavy vehicles etc. results the compaction of land. Compaction of land lowers the infiltration process and lower infiltration rates. The major hydraulic properties in turn govern infiltration rates.

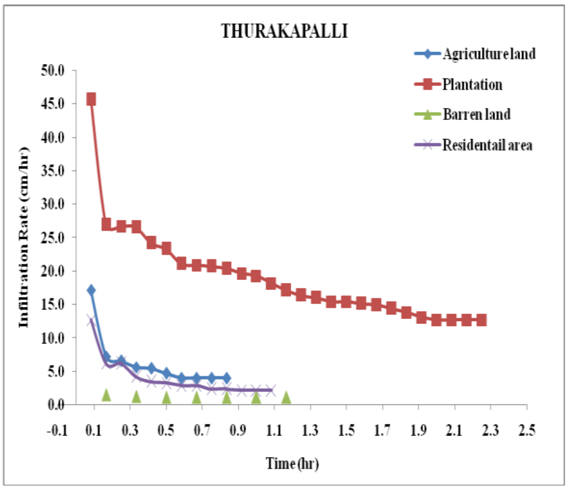

Figure.4 Infiltration capacity curve for Thurakapalli village

Figure.5 illustrates the infiltration capacity curve for Pichinaidupalli village for all the areas. It is found that the high infiltration rates for plantation areas and the least infiltration rates for both the barren land and residential land. The infiltration for plantation land and agricultural land shows the similar infiltration trend.

The rate at which a given soil may perhaps absorb water at given time is called infiltration rate and it depends on soil characteristics such as soil texture, hydraulic conductivity, soil structure, vegetation cover etc. However, if infiltration rate of given soil is less than intensity of rainfall then it results in either accumulation of water on soil surface or in runoff.

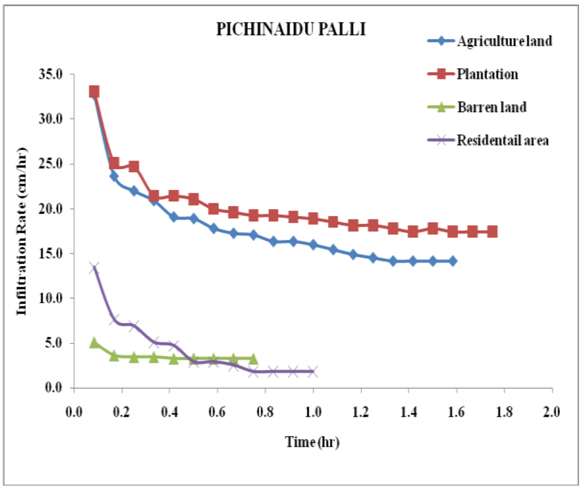

Figure.5 Infiltration capacity curve for Pichinaidupalli village

V. CONCLUSIONS

From the present work it is observed that the infiltration rate effected by different soil conditions and land types.

We conclude that the groundwater recharge in shallow unconfined aquifers where groundwater levels respond distinctly to rainfall. With different rainfall or abstraction inputs, different scenarios can be simulated to estimate the water level fluctuations and calculate recharge, which could provide valuable information for water managers. It is not a data-intensive method but a good knowledge of the hydraulic properties of the aquifer is required.

The use of surface percolation devices such as grass swales and percolation ponds recharge pits that have a substantial depth of underlying soils above the groundwater is preferable in these villages for sustainable development of groundwater recharge.

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