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ANALYSIS OF GROUNDWATER WATER HARVESTING INWEST BENGAL

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ABSTRACT: *Water is one of the most essential constituent of life on earth. It exists in all the three forms i.e. solid, liquid and gaseous states. One third of the earth"s surface is covered with water and the total water resource is estimated to be 1.37 x 108 million hectare-meters (Raghunath, 2007). Out of the total available water resource 97.2 percent is saline water mainly found in oceans and seas while 2.8 percent is available as fresh water. Out of 2.8 percent available fresh water 2.15 percent is trapped in glaciers and ice-caps, 0.6 percent exists as groundwater, 0.1 percent is found in lakes and reservoirs, 0.001 percent is available as atmospheric moisture and 0.002 percent is available as soil moisture (Raghunath, 2007). But only 0.3 percent out of 0.6 percent of groundwater is economically extractable which means that groundwater is the largest source of fresh water on earth"s surface. Groundwater is replenishable but a finite resource (Chatterjee & Purohit, 2009) and hence we should be more concerned towards its sustainable use. In this paper reviewing different authors work in order to identify research gaps.*

Keywords: Geography, Groundwater and Aquifer

I. INTRODUCTION

Groundwater is one vital element in the cycle of hydrology (Figure 1.1) It is that is stored beneath the ground in formations of geology, referred to as Aquifer which is the result of the infiltration of rainwater as well as surface water. In sedimentary and alluvial rocks it's found in the pore space between grains. In the hard rock, it is mostly caused by secondary porosity and permeability that result from fracturing, weathering, cracking, and jointing. In hard rock's like granite and schist, aquifers tend to be poor aquifers since they have extremely low porosity. But, if the rock types are fractured extensively and weathered, then they are excellent Aquifers.

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Groundwater is among the most important resources available to mankind, however due to the uncontrolled development, the resource has been put under pressure in a variety of areas of the developing world. Quantification and determination of distribution of groundwater within the system of aquifers is of vital importance to better managing groundwater resources.

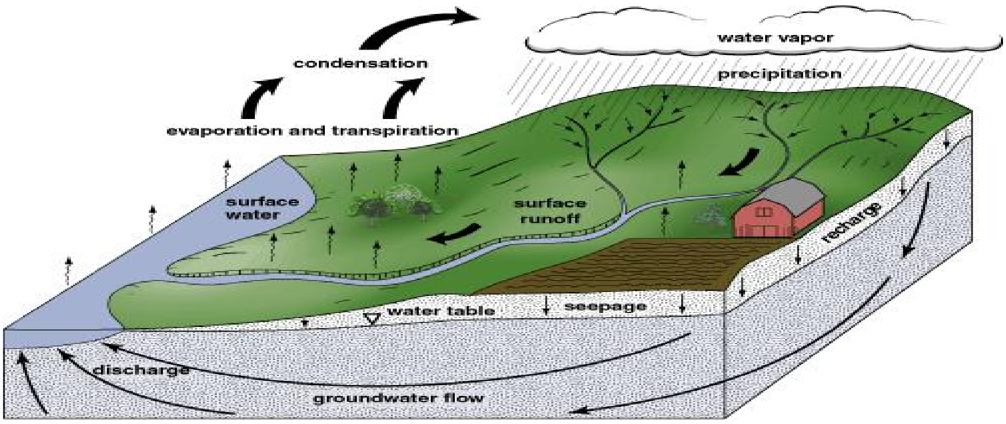

Figure 1.1: The Hydrological Cycle

(Source: http://www.isgs.illinois.edu/research/hydrogeology/hydrologic-cycle)

Groundwater occurrence Groundwater

Aeration zone

It is made up of interstices that are occupied mainly by water and a portion by air. Vadose water (unsaturated zone) is the result of the aeration zone. The entire zone is divided into soil zones that are water-based as well as between the Vamoose zone (sub-soil zone) and the capillary zone.

1.2. Zone of saturation

In the region of saturation the interstices are filled with water under the pressure of hydrostatic. The zone extends from the topmost layer of saturation to the bottom impermeable rocks. If there isn't an above-ground impermeable stratum, the prelatic or water table layer forms the upper part of the region of saturation. It is defined as the region that is a result of the atmospheric pressure. It can be described as the elevation at which the water is situated in a well, which penetrates the aquifer. In reality it is slightly above the level of the water table as a result of capillary attraction. The water is however held at less pressure than atmospheric. The water found in areas of saturation is typically referred to as groundwater, however the term “prelatic" water is be used.

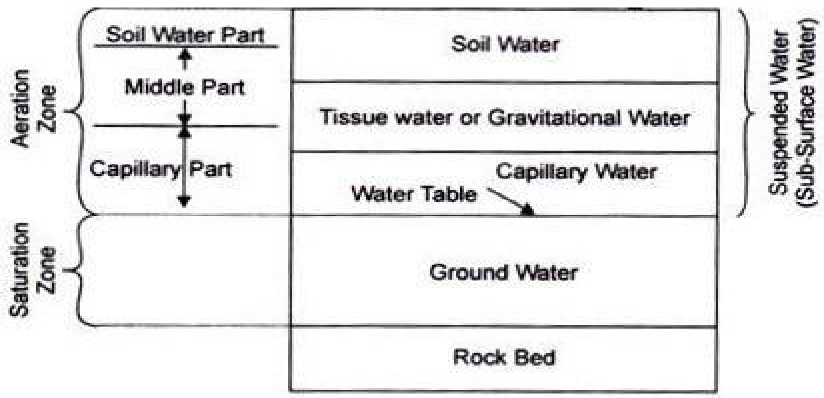

Figure 1.2: Subsurface Water Zonation (modified after Todd 1980)

1.3. Types of Aquifer

Confined Aquifer

This is an aquifer surrounded by confining layers made mostly of clay, which limit the flow of groundwater. The confining layers generally offer protection against contamination from the surface as they stay deeper than the aquifers that are not confined. The groundwater in these layers is subject to a high pressure. Whenever it is perforated by a well the water level rises above the surface of the water aquifer. Storage coefficients of artesian aquifer vary between 0.00005 up to 0.005. The confined aquifer can also be called Artesian Aquifer.

Unconfined Aquifer

This aquifer does not have any confining layers that separate the level of the water and the ground level. Thus, groundwater is able to seep in directly from the atmosphere via the cracks in the top layer of soil or rock. This is because groundwater isn't at an extreme pressure. The storage coefficient of an unconfined groundwater can vary between 0.05 up to 0.30.

Perched Aquifer:

It is like the confined aquifer, in that it has confining layers under the groundwater however, it is above the water table. This kind of aquifer is when groundwater is located above rock formations that are not saturated due to an impermeable, discontinuous layer.

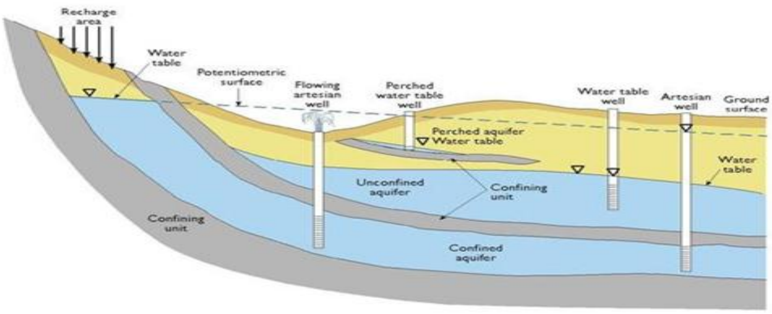

Figure 1.3: Schematic Cross-Section of Aquifer Types

(Source**:** modified after Harlan, 1989)

1.4. Climate and Rainfall

The climate in the region is subtropical, moderate and humid. The maximum temperature in summer reaching 16 to 27degC and the minimum in winter ranging between 4 to 14 degC. Jaintia Hills' climate Jacinta Hills is subtropical with distinct dry and wet seasons. The wet season runs from April through October, then a dry time between November and March. The annual total rainfall for the district as reported at Rymphum Seed Farm, Jowai is 3597 mm, 26, 08 mm and 3851 mm during the years 2012, 2013, and 2014, respectively.

Physiographic

The area is part of the Shillong Plateau. It consists of hard rock formation and exposes different suites of Precambrian gneisses and Shillong Group quartzite along with younger intrusive and sedimentary rocks. The Northern and central part of the area under review is a highly dissected and rugged terrain termed to a large extent, by strike ridges and valleys which trend along NNE- SSW trend. The highest pointwithin the study area is 1360m at Myrjai and the lowest point is 1190m at Sahbsein.

Drainage

The drainage system in the district can be managed through topography. The rule of thumb will be to have two distinct watersheds in the district: one flowing towards the northern direction towards Brahmaputra while the second is one flowing to the south, towards to the Surma valley of Bangladesh. The main rivers that flow to the Brahmaputra are Kopili, Myntang and Mynriang and the principal rivers flowing toward the Surma valley are Myngngot (Umngot), Myntdu, Wah Prang, Wah Lukha and Wah Simlieng. The patterns of its drainage are parallel and sub parallel. It is controlled by joints and faults that are evident by the straight lines of rivers and streams which are deep canyons.

1.5. THE STUDY AREA

The Northern portion of West Bengal is selected for the study. The area chosen is based on various reasons. The first is that the area of study is part of the Indo-Genetic plains, in which broadly falling groundwater is a major aspect. Second this researcher has extensive knowledge of this part that is West Bengal. This State tract comprises Districts Faridabad, Palwal, Gurgaon, Mewat, Rewari, Mahendergarh and Bhiwani. These districts are all located in the fresh water quality zones in the State. The region is arid which is characterized by hot temperatures as well as lower rainfall. It is a plain region that is 300-500m above sea level, with the exception of Aravalli hills that are located in this region. Northern West Bengal is subjected to large fluctuations in rainfall from year to year, and between seasons. There are a lot of variations in rainfall and since the rainfall is often small for agriculture, and is limited to the season, this variation is even more significant. The average annual rainfall is between 300 and 600 millimeters throughout the entirety in the state. This region of the State is also significant from geological and hydrological perspectives since it has fresh quality of groundwater. Average irrigation facilities as well as average quality of alluvial and groundwater have gave it a very excellent agricultural production in recent years. Due to the fluctuations in rainfall and insufficient availability in surface waters, the farmers heavily depend on groundwater to water their crops. This is the reason why the high flow of groundwater used for irrigation has led to the loss of the resource.

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II. REVIEW OF LITERATURE

Healy and Cook (2002) studied the methods to estimate of groundwater recharge using groundwater levels and found that the water table fluctuations method is most appropriate for areas with a water table that is shallow with rapid rises and drops. It is possible to apply it in simulations when wells tap into to the table and sufficient water-level data are available.

Adhikari et al. (2003) stated that in Bellary the most rainfall was recorded during September, which was followed by the months of the months of October and June. It was noted the average of 240 millimeters rain fell in the period between the months of January and August, of which 210 millimeters occurred during the period between the months of May and August. In the three months i.e. from September to November, the rain fell at 257 millimeters.

Fiedler (2003) determined the weights of stations of rain by using Thiess an Polygons and Isohyets method. The method demonstrated the elimination of biases over time due to the spatial variations of rainfall as implied by Thiess an Polygons and more precise spatial distribution was portrayed by the Isohyets method.

Narain et al. (2005) investigated the possibilities of water harvesting and conservation to combat water shortages across the Indian state of Rajasthan. It was discovered that, despite the depletion of water resources in the state, it still has a significant opportunity to harvest and conserving water, if an integrated approach to managing water resources is followed and the right policies and investments are put into place with the latest technology.

Ravi et al. (2007) calculated the recharge rate from ground water in the Noyyal river basin in Coimbatore. They attempted to determine the rate of recharge within the Noyyal river basin by using the water level fluctuation method. It is believed that the Noyyal basin is divided into the lower Noyyal, Avanashi and lower Noyyal sub-basins. It covers all drainage basins within the Noyyal River (3,510 sq. kilometers) it is an tributary to the Cauvery River which flows towards the east and connects it via the Bay of Bengal.

Jha and Sharma (2009) highlighted the importance of area-based strategies to manage groundwater resources based upon the availability and demand of a particular region. Based on the most recent analysis the annual replenish able groundwater resources of the this country is estimated to be 433 billion cubic meters (bcm) from 399 bcm. It is believed to be available to develop for various purposes. The irrigation industry is the largest user of groundwater which accounts for the majority of the annual withdrawal.

Ishappa et al. (2010) examined the characteristics of rainfall in the Coimbatore District, which includes the distribution of rainfall and variations across seasons, the ratio of precipitation and frequency of occurrences and observed that the southwest, south and northwestern areas of the district receive the most heavy rainfall, while the lowest rain-prone areas are in the northeast, east and the southeastern part in the district.

III. Motivation

As per the latest nationwide assessment on groundwater depletion by National Groundwater Management Improvement Program (NGMIP), seven states namely Gujarat, Maharashtra, Haryana, Karnataka, Rajasthan, Uttar Pradesh, and Madhya Pradesh have some of the most heavily exploited areas of groundwater in India. NGMIP program declared that 25% of the groundwater blocks are critical, which indicates the deteriorating situation. The climate change and depletion in aquifers lead to scarcity in the availability of groundwater. The depletion of this precious natural resource may lead to severe implications such as food security and other factors, which will affect agricultural development and the economic growth of the country. Researchers are striving hard to improve the prediction accuracy of GWL forecasting. With the fast growth in hybrid soft computing technologies, the demand for predicting this in the regional scale is increasing. Moreover, the department of CGWB, State board, Government of India has promoted a program that aims to develop and utilize various tools to forecast the GWL to interpret its status.

In the design of a successful GWL forecasting model, some of the important requirements that are to be considered are:

(i) The spatial variation of GWL over the identified study area must be plotted to visualize the data.

(ii) The model must be accurate, which means that it must have a specified level of prediction accuracy for seasonal variation.

(iii) The GWL forecasting model is location specific and must provide valuable input to the study area for effective groundwater resource management.

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In this work, the GWL forecasting model is considered as a potential application in regional analysis of its trend. The GWL prediction model uses different government agencies to use traditional tools like QGIS for its analysis. At present, accurate prediction of the GWL trend with available data using soft computing approach is very much important. Considering the above facts and applications, we believe that the research investigation on GWL forecasting is very relevant and helpful. So, through this work, the GWL forecasting model, with its possible applications in managing precious resources/ sustainability, has been proposed.

IV. CONCLUSION

Groundwater has a vital role in the environment as it aids in the replenishment of streams, rivers and wetlands. In addition, the development of a nation is largely dependent on the availability of groundwater. The growing population and the changing social circumstances have an impact in the capacity of groundwater. The groundwater resources need to be protected because in many regions there is a rate for withdrawal that's much higher than the recharge rate. To ensure the effective use of groundwater resources, the appropriate evaluation and guidelines for managing the groundwater resources are needed. Rainfall is the primary source for groundwater recharge within the Amaravathi basin. In this instance it was decided to find out the link between the depth of rainfall as well as the depth of the groundwater table. Groundwater modeling attempts to replicate the nature of natural groundwater systems by defining the basic characteristics of the whole system in a precise mathematical or physical method. This is why research into the evaluation of hydrological variables as well as the development for a model of groundwater in the Amaravathi basin was carried out. The study is incorporated into Amaravathi basin, which covers an area of 8544 square kilometers (PWD WWR 2015) includes Coimbatore, Karur, Tirupur and Dindigul district in Tamil Nadu. The groundwater resources are studied thoroughly. To analyze the data rain data for 44 years (1971 to 2014) was collected from the State Ground and Surface Water Resources Data Centre, Tharamani, Chennai. The groundwater levels for 44 years (1971 until 2014) were taken from twenty-four observation wells. The aquifer's response to recharge triggered by recharge patterns and rain was studied for the entire basin. The quality of the groundwater in the area of study was assessed with respect to changes in the table of groundwater and the proportion of recharge. Groundwater recharge was calculated through the use of fluctuation in water levels and formulas using empirical data for each station individually. To track and protect the groundwater resources areas that could be recharged, they were recorded using RS & GIS. A Multiple Influencing Factor method was used to calculate weights for each theme map. A weighted overlay within the model builder software which is part of the Arc GIS software was used to overlay the different themes to reveal the recharge zones for groundwater in the study area. The model of multilinker regression was designed and tested to establish the relationship between the groundwater table and the rainfall inside the basin. The performance evaluation on artificial recharge structure is a measure of recharge of groundwater quality and quantity in the Amravati watershed to assess the rate of recharge growth in comparison to recharges from natural sources.

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