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Relation of Ground Water Level Fluctuation with Rainfall in Sylhet

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Abstract:

This study was conducted in Sylhet city to evaluate the effect of rainfall on ground water level fluctuation for a study period 1992-1998. The rainfall, Evapotranspiration and Ground water level data was collected from WARPO. The data was analyzed and the study found there is a significant relation of rainfall with ground water level fluctuation. Ground water level of Sylhet city is declining gradually though there is no significant change in annual rainfall amount. This was mainly for huge amount of ground water abstraction as a side effect of rapid urbanization in the city.

Key words: Ground water level, Rainfall, Sylhet City, Urbanization, Evapotranspiration.

Introduction:

Ground water is the water available in the saturation zone. A large amount of water is stored in the shallow depths. About 30% of world's fresh water resources exist in the form of ground water and it is free from pathogens.[1] In Bangladesh drinking water supply mainly based on Ground water sources.[2] Most of the 150 million populations in Bangladesh are extracting water from shallow aquifers as a primary source of drinking

and cooking water. An estimated ten million domestic wells are withdrawing water for water supply in rural areas of Bangladesh and urban water supply is also heavily dependent on it.[3] Total irrigation water use in Bangladesh estimated 246km3 annually (2004-2005) and 18 km3 of which comes from ground water. [4]

In Sylhet city Ground water is one of the main sources of water. For agriculture and municipal use the withdrawal of ground water is going on. Sylhet is a growing city and its rapid urbanization effecting on the ground water. Urban areas generate more run-offs generally. But they disturb the natural infiltration by increasing the impervious surface. This disturbance in infiltration is responsible for ground water lowering. Urban areas are now filled with a large number of buildings. Unbroken materials of concrete/asphalt etc during construction work can also disturb the precipitation from entering in to the soil. Extensive ground water extraction's common effect is Land Subsidence. Experiences from other countries indicate that at least 9 meters of permanent lowering of groundwater table causes 30 cm of land subsidence.[5] On the year 1960-1985 and 1986-2010 rainfalls during summer, critical period and monsoon have an increasing trend by 24.5%, 33.8% and 1.13% respectively comparing the two halves of time period. But the rainfall in winter has decreased by 35.2%. [6]"Exploitation or over withdrawal of groundwater resources imposes stress on groundwater regime distorting the aquifer recharge-withdrawal equilibrium and as a result, a continuous decline in water table may occur causing much adverse surface and subsurface environmental effect" [7]

2. Materials and Methods

2.1. Study Area

The study area Sylhet city is situated on the banks of Surma River. Sylhet City Corporation has a population of estimated

500,000 people and an area of 26.5 square km. It is the fifth largest city of Bangladesh and located on the North-Eastern part of the country map. Geographical location of the city is at 24.8917°N 91.8833°E. The climate of Sylhet is humid subtropical with an average highest annual temperature 23 °C (Aug–Oct) and average lowest temperature of 7 °C (Jan). Sylhet Municipality was established in 1878, almost 136 years ago but actual expansion of municipal area started after the Liberation war of Bangladesh in 1971. The 1971 war of liberation accelerated the rate of migration which led to rapid urbanization in Sylhet.

Sylhet consists of 27 wards and 210 Mahallas. Bangladesh National Building Code (1993) has placed the city on Zone III on seismic map, which is a zone of high seismic risk with a basic seismic co-efficient of 0.08.[1]

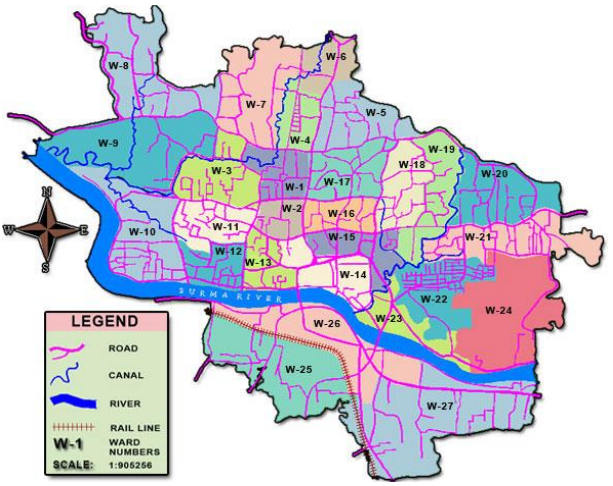

Figure 1 Sylhet City Map

2.2. Data Collection

Rainfall, Evapotranspiration and Ground water level data was collected from The Water Resources Planning Organization (*WARPO*) which is an organization under Ministry of Water Resources, Bangladesh.

2.3. Runoff

"Runoff means the draining or flowing off of precipitation from catchment area through a surface channel. It thus represents the output from the catchment in a given unit of time." Runoff is a major component of water cycle. Evapotranspiration, initial loss, infiltration and detention requirements will have to be satisfied before the commencement of runoff for a given precipitation. [1] Runoff is also the primary agent in soil erosion.

Calculation of Runoff can be done by following equation, here P is rainfall coefficient and k_b is Runoff coefficient.

$$R=k_b \times P$$

2.4. Infiltration

Water on the ground enters into the soil by infiltration process. Two forces gravity and capillary action is mainly responsible for infiltration. Also infiltration depend on soil characteristics including ease of entry, storage capacity, and transmission rate through the soil, soil texture and structure, vegetation types and cover, water content of the soil, soil temperature, rainfall intensity etc. During the early part of a storm infiltration capacity rapidly declines and then after couple of hours tends towards an approximately constant value. [2]

Infiltration can be calculated by the following equation

$$I= P-ET-R$$

Where, I, P, ET and R are indicating the Infiltration, Rainfall, Evapotranspiration and runoff, respectively.

3. Results and Discussions

3.1 Rainfall Variation

The rainfall variations of Sylhet during 1992 to 1998 are shown below in fig-2. The maximum rainfall was found on the rainy season June-July and minimum rainfall was found between November to February. The maximum rainfall of this study

period was in July of 1998. On July, 1993 there was also good amount of rainfall which is very nearer to the maximum.

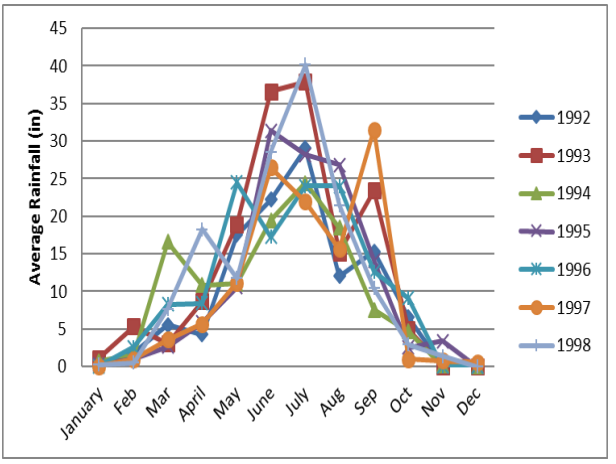

Figure 2 Rainfall Variation

3.2 Estimated Runoff

The maximum annual rainfall was recorded on 1993. On 1994 there was a fall in rainfall amount. Estimated runoff is shown on the third column. This result showing that on 1993 the amount of estimated runoff is maximum. After this there was a little decrease in the runoff amount as rainfall decreased in this period. On 1998 there is a rise on estimated runoff with an increase in annual rainfall amount.

$$R=Kb\times P$$

Where P and Kb are the rainfall and the runoff coefficient, respectively.

Year	Annual Rainfall (mm)	Runoff (mm)
1992	2864	572.4
1993	3881.75	776.35
1994	2887.25	577.45
1995	3127.05	625.41
1996	3272	654.4
1997	2987.25	597.45
1998	3587.23	717.45

3.3 Estimated infiltration

Highest infiltration in Sylhet region was in 1993 as the rainfall was maximum in this year. Since then infiltration decreased and on 1998 there is a rise on infiltration amount. The highest infiltratin estimated is 3102.15mm and lowest is 2288.2mm.

$$I = P\text{-}ET\text{-}R \quad \text{(ii)}$$

Where, *I, P, ET* and *R* indicate the infiltration, rainfall, evapotranspiration and runoff, respectively.

Year	Evapotranspiraion	Infiltration (mm)
1992	3.385	2288.2
1993	3.2441	3102.15
1994	3.4441	2306.35
1995	3.3408	2498.74
1996	3.3458	2614.25
1997	3.3516	2386.45
1998	3.2425	2866.54

3.4 Relation between rainfall and Water level fluctuation

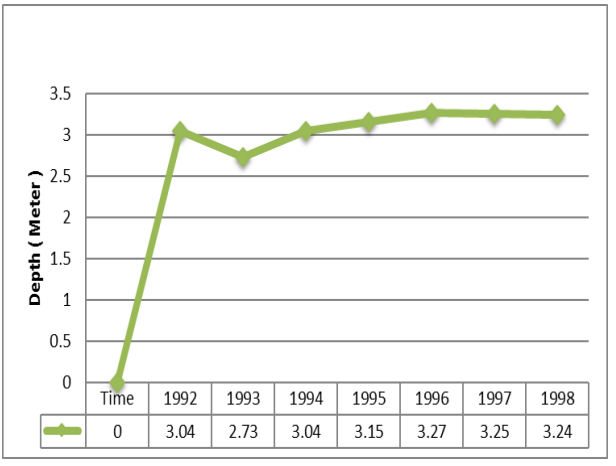

Figure 3 Groundwater Level Fluctuation

Fig3 showing the ground water level fluctuations of the study area between 1992 and 1998. On 1992 the rainfall, runoff and infiltration were minimum and on this year ground water depth was 3.04m. And on 1993 the rainfall, runoff and infiltration

were maximum and on this year ground water depth was minimum. . Ground water table recharged by the rainfall by a large amount on 1993, so there is a decrease in ground water level depth in this year. This is a clear indication of the effect of rainfall on groundwater level. From 1994 the rainfall decreased and also infiltration. So the ground water depth is increasing. On 1998 there is a slight decrease in ground water level depth for the increase of infiltration due to rainfall of that year. This study showing that there is a very close relation between rainfall and infiltration with groundwater level fluctuation in Sylhet.

Ground water extraction due to irrigation and municipal purposes is increasing with time. Sylhet is a growing city and rapid urbanization is responsible for huge ground water extraction. For these factors, we are observing that, the ground water level depth is increasing on 1996 to 1998 though in 1998 there was a good amount of rainfall.

Conclusion and Scope for Study:

Ground water level in Sylhet city is declining day by day. Urbanization in this city should be done with proper urban planning considering all aspects of the environment. As this area is situated in the most earthquake risky zone lowering of ground water can cause huge destruction by land subsidence on earthquake. The excessive pressure on ground water can be minimized by rainwater harvesting. The condition of ground water level can also be improved by artificial ground water recharge. There is a further scope of study on ground water fluctuation due to abstraction of groundwater in Sylhet city for irrigation and municipal use.

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