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Diyarbakır Plain Groundwater Levels Mapping and Modeling Using Boring Data and GIS

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Abstract:- Diyarbakır Plain, a part of the historical Mesopotamian Plain, has been home to many civilizations. One of the most basic reasons for this is that it has fertile soil and partly rich groundwater and surface water resources. Agricultural irrigation has begun to be realized especially with agricultural grounds for the between 1990-2007 years. This situation threatens the groundwater potential of Diyarbakır Plain. In this study, static and dynamic water level maps of Basin were extracted using ARC INFO program as Geographic Information System. Dynamic and Static water levels are high in 600 m topographical areas, but levels are low from 700 m elevations and especially in the northern parts of Plain. In addition the level values obtained at the end of this study are the values of Diyarbakır Plain up to 2007 years. It is better to update these level maps with new and up-to-date studies.

Keywords: *Diyarbakır Plain, GIS, Groundwater, Static Water Level, Dynamic Water Level*

I. INTRODUCTION

Diyarbakir hold its importance throughout history mainly for its location where many civilizations cultivated in Upper Mesopotamia met and interacted. Archeological studies show that the history of the plain extends to the Paleolithic age. Groundwater and surface water sources are the main reasons for the civilizations to live here. Diyarbakır basin; is still a popular to precious agricultural and water resources due to water resources.Groundwater, have a considerable share of 30% in fresh water sources worldwide [1]. Due to about 70% of water resources is taken into consideration from the polar icebergs and snow, ready for use, water is obvious efficient management of the importance of ground [2]. Amounts of Precipitation which remaining total from precipitation to surface flow and the amount remaining after evaporation, leaks deep into the soil and groundwater or filtered through a aquifer formations. Precipitation mixed with groundwater varies depending on climatic conditions. The amount % 10-20 of rainfall on groundwater in The Mediterranean climate interfered, but in hot and dry climates, may go up the rate of 2% [3]. UNESCO'S Report indicated that in 2025, 1.8 billion (one billion eight hundred thousand) people in the world will have experienced water scarcity [4]. It is reported that, in the last decade In 80 countries, 40% of the population could not reach the required amount of water at the competent level [5]. It is highly probable that this rate will increase in the coming years. Between the years 1960-1997, per person usability fresh water has decreased by approximately 60% in the world. The amount of available water per person is expected to decline by 50% until 2025 [6]. While In 1940, total world consumption was 1000 km3 of water, in 1969 this amount doubled over. In 1990, the world's total water consumption occurred in 4130 km3 and 2680 km3 of this amount (65%) is used for irrigation, 950 km3 (23%) third of the drinking water, 500 km3 (12%) thirds is used in the industrial sector [7].Annual mean precipitation in Diyarbakır plain is nearly 550 mm, which corresponds to 9,05 Bm^3 (billion m^3) of annual water volume in the city. Nearly 3,1 Bm^3 of volume of water leaks into groundwater, whereas 1,2 Bm^3 is retrieved by springs from groundwater contributing to surface water. Considering this rainfall data, it is seen that the Diyarbakır Plain does not have very rich water resources. But according to the Mesopotamian region it has a partially high water budget. Besides, Turkey is not a rich country in terms of existing water potential. The annual exploitable amount of water has recently been approximately 1,500 m3 per capita [8]. In 2003, 40.1 billion m3 volume of water was consumed in various sectors in Turkey; nearly %73 of water used in the irrigation sector, %15 of water used in the water supply sector, and %12 of water used in the industrial sector. The average annual surface run-off in the country is about 186 km3, of which only 98 km3 could be technically and economically developed for consumptive use. Considering the 12 km3 of groundwater safe yield, the total amount of exploitable water has been assessed as 110 km3. However, only 38% (42 km3) of the total water potential is used presently [9]

II. MATERIAL AND METHOD

2.1. Investigated Site Basin Properties

Turkey has a subtropical climate in the warm temperate zone and Diyarbakir is located between 40-44º East and 37-55º North lines and which has step plant cover and the North of this country is surrounded with mountains.

In most of soils, the ground water is high and in Diyarbakir a mix agricultural cultivation (dry and watered) is practiced. Diyarbakir belongs to Southeast Anatolian Province. The province of Diyarbakir extends over an area of 15,355 km2. The population of the province is 1,665,209 according to the Census of 2015. The outlying districts of Diyarbakır are Bismil, Cinar, Cermik, Cungus, Dicle, Egil, Ergani, Hani, Hazro, Kocakoy, Kulp, Lice and Silvan [10]. Diyarbakır basin, located in the eastern half of the region, is surrounded by Taurus Mountains in the north and north-east, Mardin-Midyat threshold in the south, and Karacadağ volcanic mass in the west (Figure 1). Between with the Tigris River and the Southeast Taurus Mountains lying a wide area is called the Diyarbakir basin. The mid-elevation mountains of Mardin are located at the south of this partition. Extending from the northwest to south altitude of Karacadağ, separates the Diyarbakir basin from Sanliurfa Plateau. An extinct volcano Karacadağ -height 1954 m- is the highest point of the region.
The Euphrates River forms the western region boundary. In the east located Ambar and Göksu Streams blends in the Tigris River. Natural vegetation and forest of areas has not developed. In the area has been observed more maquis and bush.

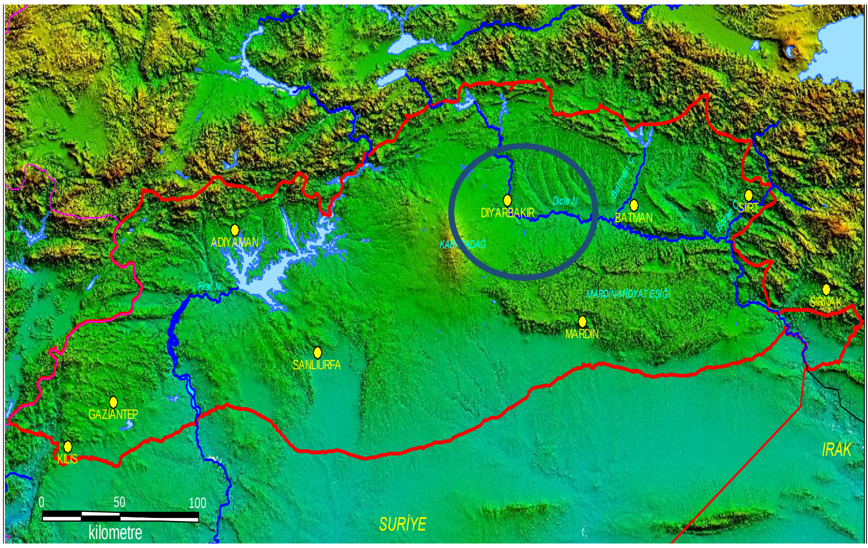

Figure1: Diyarbakır Basin Location map.

2.2. Climate and Rainfall Forms

Diyarbakır has a semi-arid climate. The summers are very hot and dry which effected hot winds from desert of Syria to the south. But winter colds are not as severe as they are in Eastern Anatolia. The main reason for this is that the Southeastern Taurus broadcast cuts off the cold winds coming from the north. The highest recorded temperature was 44.8°C (112.64°F) on 28 August 1998. Snowfall is quite common between the months of December and March, snowing for a week or two. Snow melt extends from January to June with important discharges upstream of the Tigris River in March, April and May. The temperatures range between –9ºC and 48ºC in the Northern part of the catchment area but the minimum temperatures increase towards the South[13].The lowest recorded temperature was -23.4°C (-10.12°F) on 30 December 2006 (Table 1). Diyarbakir basin’s annual precipitations of 814 mm. The highest values, 1'330mm, were recorded at Lice in the northwestern part of the catchment, whilst the minimum was observed in the Bismil plain (400 mm).

Actual Average Values in Long Period (1970 - 2011)												
Months	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Temperature(^{0}C)	1,6	3,6	8,6	13,8	19,2	26,3	31,2	30,3	24,7	17,1	9,0	3,7
High Temperature(^{0}C)	6,6	9,0	14,7	20,2	26,5	33,7	38,5	38,1	33,3	25,3	15,9	9,0
Low Temperature(^{0}C)	-2,5	-1,2	2,7	7,1	11,3	16,9	21,7	21,0	16,0	10,1	3,6	-0,5
Sunshine Hours(hour/day)	3,6	4,5	5,4	6,6	9,4	12,1	12,3	11,4	9,6	7,2	5,2	3,5
Rainy Days	11,7	11,6	11,4	11,9	8,9	3,0	0,4	0,3	1,2	5,8	8,0	10,8
Monthly Precipitation(kg/m^2)	62,8	67,8	67,3	67,7	39,6	9,0	0,4	0,4	4,3	32,1	51,1	67,4

2.3. Groundwater Resources

2.3.1. Hydrogeological Conditions

The upper units and the bedrock are semipermeable and impermeable, respectively. The conglomerate and sandstone layers within the bedrock result in a noticeable increase in the overall permeability. The depth to the perched groundwater level varies from 6 up to 10 m with elevations averaging some 585 m above mean sea level, i.e. similar to the water level in the Tigris River. The morphological appearance of the area is characterized by a wide valley lying between parallel hills. The units located in the middle part of the study area are generally impermeable. Groundwater is recharged from the valleys in the west and seeps through open discontinuities in the basalt rock mass (Fig. 2). Seepages are also observed along the boundary between the basalts and the Tertiary deposits [14].

III. METHOD

The determination of the study for potential groundwater of Diyarbakir basin with GIS (Geographic Information Systems), the water well logs which have been drilled by the private and public sectors were examined. In this study, around 600 water wells which drilled in the year between *1960-2007* for irrigation or drinking water were analyzed, and similar to that of the basin coordinates extracting data from would take advantage the available 392 pieces of water wells were observed and exploited (Figure 2). The final thematic map production was started using data from boring wells. First, the static water level depth map issued (Figure 3), Static Water Level maps are being prepared using the available wells data obtained from the static water levels using Geographic Information Systems (GIS) are modelled for all of the Diyarbakır Plain. Thus, static water levels were determined for regions where no water wells drilled or that are not from the data. Similar of this method was also used in obtaining Dynamic Water Level thematic map (Figure 4). The Dynamic Water Level Map prevents unnecessary drilling for wells. At Figure 5 also at the same the logs of wells map is produced that determines the relationship between dynamic and static level.

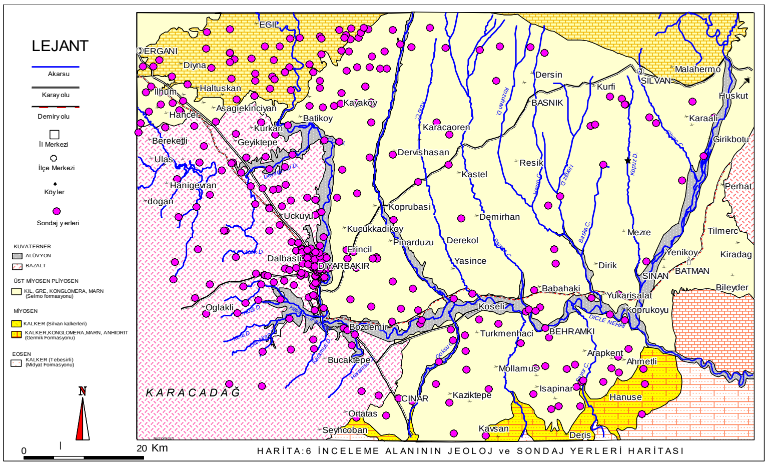

Figure 2: Boring Locations with Geological Map of the Studied Area

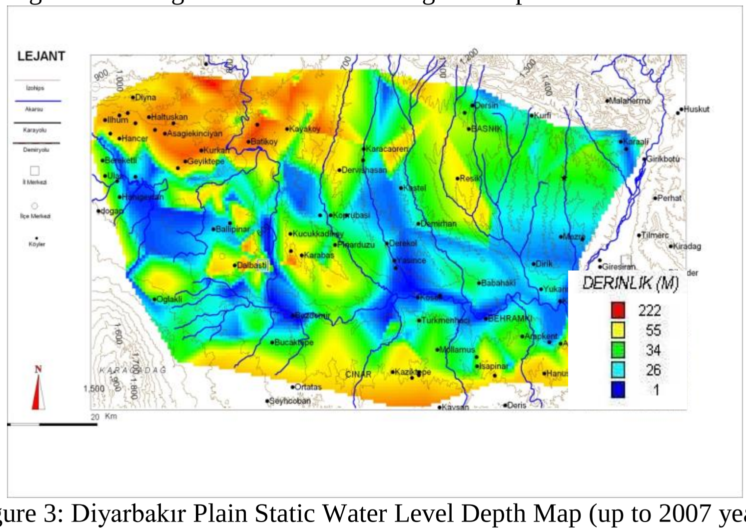

Figure 3: Diyarbakır Plain Static Water Level Depth Map (up to 2007 years)

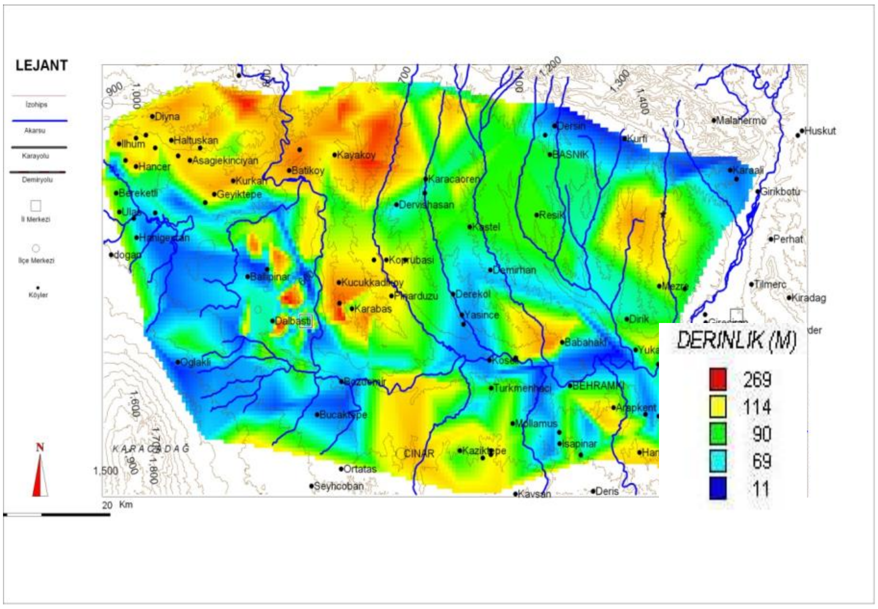

Figure 4: Diyarbakır Plain Dynamic Water Level Depth Map (up to 2007 years)

IV. RESULTS

The results obtained from static and static water level maps during this study have been submitted item by item as below:

1. Components feeding Diyarbakir groundwater resources are underground flows towards lowlands resulting from rains on Toros Mountains at North and Karacadag at West. Average rain amount of these regions is about 1000 mm on a yearly base (Average rain of the lowlands is approximately 500 mm). This is an important amount as per feeding ground-water resources.
2. Alluviums in water beds of Tigris and Batman stream are suitable in general to get ground-water. But there is no need at most locations for ground-water resources because of big rivers flowing on alluviums. In general, it is possible to get ground-water from alluviums of the river Tigris beginning from south of Silvan limestone up to the location where it leaves the plain.
3. Delaying of projecting for irrigation in GAP region has concluded widely usage of under-ground resources. It is observed - especially in dry seasons - that activities for well digging are increased. This huge amount of discharging water shall result seasonally in diminishing of static water level. So exploiting under-ground water resources for new applications must be strictly restricted.
4. Examining maps in Fig. 3 and Fig. 4, it will be observed for the Basin that static level of ground-water at high locations increases up to 55 m while it is about 1 m for just lower and higher sections of the river Tigris. The depth exceeds 100 m at some locations. Static water level at lowlands differs from 2 m up to 55 m. Dynamic water level of the region varies between 11 m and 69 m at locations with basalt, water bed of the river Tigris where has alluvium and at Silvan lowland. This depth varies between 90 m and 114 m between Cinar Ortatas, Kaziktepe and Kavsan while it varies between 90 m and 269 m at the triangle between Ergani, Egil and Kocaköy, at the northern district of Diyarbakir.
5. Static water level varies between 1 m and 26 m at the region of the village Bozdemir up to the village Koprubasi which takes part at the southern region of Diyarbakir. Dynamic water level there varies between 11 m and 114 m.
6. Static water level between the villages Koprubasi and Korukcu varies between 1 m and 26 m. Dynamic water level there varies between 11 m and 96 m.
7. Another region begins from the location between Bismil and (Behramki) then extends towards the East at the both sides of the river Tigris. Static water level there varies between 1 m and 26 m while dynamic water level varies between 11 m and 90 m (Figures : 3, 4 and 5).
8. As for the region of Köseli – Yasince — Derekol – Demirhan, static and dynamic water levels are 1-11 m and 11-30 m respectively.
9. For low elevations (not exceeding 600 m) in water basin of the river Tigris arounds, the dynamic water level is 50-60 m while the static water level is about 1-20 m. Underground water at these levels acts as artesian well.

10. Static water level at water basins of Tigris and the stream Batman is about 1 m while their dynamic water levels vary between 11-25 m.

    The level values obtained at the end of this study are the values of Diyarbakır Plain up to 2007. It is better to update these level maps with new and up-to-date studies.

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