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Determination of Tigris Bismil Agricultural Plain's Groundwater Static Water Level (SWL) Changes Caused by Irrigation Using GIS Technic.

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ABSTRACT: The unconscious use of groundwater in agricultural irrigation threatens the potential and level of groundwater. So it is imperative to follow the groundwater Static Water Level (SWL) change in places where watering with the groundwater is made. The reason for the study area Bismil is that Bismil district of Diyarbakir entirely on agriculture and animal husbandry in the Upper Tigris Basin. Tigris River goes through the middle of the Bismil plain. There are two kinds of agricultural irrigation takes place in this region. The first, on the edge of the river Tigris fields during irrigation pumping from River. In the latter the field which far areas from river are provided from groundwater by wells more than last 15 years. However, consumption of more than feeding to bring this situation poses a threat for the groundwater. For this reason, the region's groundwater changes are studied with the data of water well the years between 1996 and 2011. Arc Info 10.2.1 programme Spatial Analysed Extension used as GIS technic.
Keyword: Groundwater, GIS, Agricultural area, Upper Tigris Basin

I. INTRODUCTION

The importance of groundwater increases gradually as an alternative water source at the world. Due to the increasing in the population and demand for drinking water, and the increased use of water for agriculture, in addition, different threats of pollution for water resources, reduces the amount of water per capita.In addition to the climatic changes caused by irregular rainfall regimes and some years of drought, especially in semi-arid regions indicates serious problemsarising in the future.

According toUNESCO'S REPORT (2006), it is foreseen that in 2025, 1.8 billionpeople in the worldwill experience water scarcity. It is reported that, in the last decade40% ofthe populationin approximately 80 countries it seemsthat the water demand will be insufficient to meet the needs (Bennett, 2000). Annual mean precipitation in Turkey is 643 mm, which corresponds to 501 bm^3 (billion m^3) of annual water volume in the country. A volume of 274 bm^3 water evaporates from water bodies and soils to atmosphere. 69 bm^3 of volume of water leaks into groundwater, whereas 28 bm^3 is retrieved by springs from groundwater contributing to surface water. Also, there are 7 billion m^3 volume of water coming from neighbouring countries. Thus, total annual surface runoffamounts to a volume of 193 bm^3 of water. Including 41 (69-28) bm^3 net discharging into groundwater (covering safe yield extraction, unregistered extraction, emptying into the seas, and transboundary), the gross (surface and groundwater) renewable water potential of Turkey is estimated as 234 bm^3. However, under current technical and economic constraints, annual exploitable potential has been calculated as 112 bm^3 of thenet water volume, as 95 bm^3 from surface water resources, 3 bm^3 from neighbouring countriesand14 bm^3 from groundwater safe yield (Nalbantoglu,U.,2006).

The River Tigris, which is the second-largest river in the western Asia, originates near Lake Hazar (elevation 1150 m) in eastern Turkey. The Tigris is fed by several tributaries in Turkey. It forms the Turkish–Syrian boundary for 32 km, and crosses into Iraq. From the Iraqi border up to Mosul, the river is bordered by rolling hills on either side but is still confined to a deep valley in the Mosul area. Within Iraq, the Tigris has several tributaries which contribute significantly to the water potential of the river (Altinbilek 2004).The total length of the river isapproximately 1900 km, from which 523 km is within Turkey. It drainsa catchment area of about 57,614 km^2(Akbulut 2009).

The irrigated agriculture is mostly performed by water wells in Bismil. According to TUIK (2011) data, 60,000 decares of cotton, 2,500 decares of tobacco are cultivated in Bismil. Besides, production of other field crops also carried out using groundwater. Bismil District is in the domain of Batman Dam, Dicle Dam, Pamukçay dam and inBaşlar dam's irrigation project area (DVCSIM 2011). As these irrigation projects completed then start activity the need to use groundwater will reduce.

The GIS technique, with field ground surveys, is well known as apowerful technique for groundwater mapping in the world. Over the last few decades, the international scientific community has shown great interest in this topic and thus, many authors have used remote sensing and GIS techniques for groundwater prospecting Sander, 1997; Procter *et al*.,2006; Sikdar*et al*., 2004;VanderPost, 2007; Dineshkumar*et al*., 2007; Celik, R.,2015; Ozturk,M. and Celik,R.,2008;Chowdhury et al., 2010; Chawla*et al*.; Jha et al., 2010. The reason for choosing the study area as Bismil is that approximately all of the economic activities at Bismil, a district of the Diyarbakir province, depend mainly on agriculture and animal husbandry in the Upper Tigris Basin. There are two kinds of agricultural irrigation taking place in this region. The first is irrigation of the fields just on the coasts of the Tigris River by pumping the water directly from the river during the irrigation session. In the latter the fields which are far from the river are irrigated providing the water from the groundwater resources by wells for more than the last 15 years. However, as the consumption is more than feeding of the groundwater resources poses a serious threat for the groundwater resources. For this reason, the changes in the groundwater levels studied using the data relevant to the water wells during the last 15 years. Bismil plain obviously good sample that may show using groundwater for irrigation how affect groundwater level changes by year.

II. MATERIAL AND METHODS

2.1 Study Area's Features

2.1.1 Geographic Structure:

The geographical location coordinates of Bismil district centre is 37°50'45" N, 40°40'33" E, and Bismil is the second largest county in the province of Diyarbakir (Figure1). It is located in the South eastern Anatolia region of Turkey. Settled on aflat land, it has fertile land of the Tigris plain. The Tigris River passes through Bismil. There are slight hills to its north and south. The South-eastern Toros Mountains are located on the south side of Bismil. Its distance from Diyarbakır is 55 kilometres; it has both the railway and highway of Diyarbakir-Batman passing through it. Total area of Bismil district is 1748 km^2.

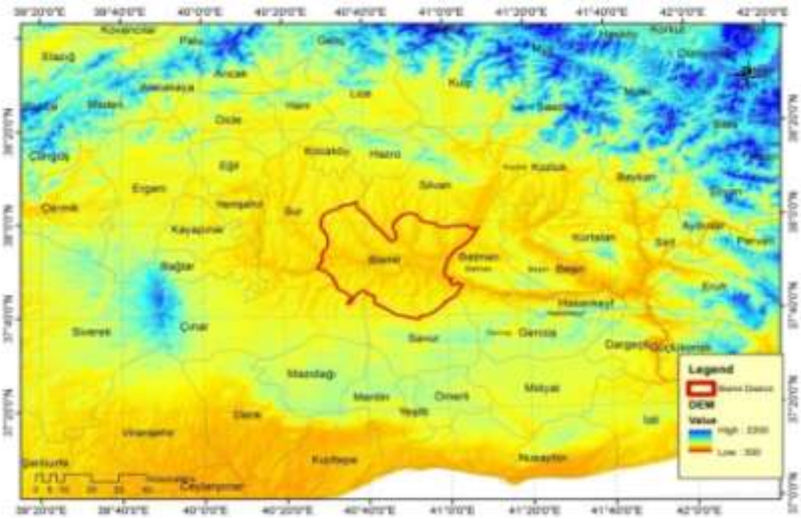


Figure 1. Bismil Urban Location map

2.1.2 Rivers and Lakes:

The Tigris River runs through Bismil, and many small and large streams and creeks flow into it. The most important ones among these streams are Pamuk, Göksu, Kurmuşlu, Kuru, Ambar, Caferi andSalatstreams. Not exactly blessed with many lakes, Bismil has only one, which is near the Çöltepe village.

2.1.3 Climate:

Bismil has a terrestrial climate. Its summers are dry and hot, and winters are cold and rainy. The dams constructed around the sub-province in the recent years have altered its climate. The snow was remaining on the ground for months before construction of the dams, but in the recent years there is not any snowfall at all. Despite not experiencing frost, temperature goes below zero degrees Celsius during the months December and January, and above 45 degrees in the summer. Especially during July and August the heat tends to get unbearable (Bismil gov.tr, 2013). Average long term precipitation of Bismil is 447,9 mm(Table 1).

Table 1. Long term average Bismil precipitation (mm)(DVCSIM), 2011)

Dist./Month	Jan	Feb	March	Apr	May	June	July	Aug	Sep	Oc	Nov	Dec	Total
Bismil	57,9	68,6	62,1	50	37,8	9,6	3,5	0,3	0,6	32,4	56,7	68,4	447,9

2.1.4 Bismil Population

The population of Bismil has shown a noticeable increase due to regional migration in the 1990s as it isseen in Figure2. The population of Bismil shows a similar distribution as for those live in the rural areas and those in the city centre, with a proportion above the average rate of Turkey. Thereasonfor this is the heavy agricultural employment in the rural regions.

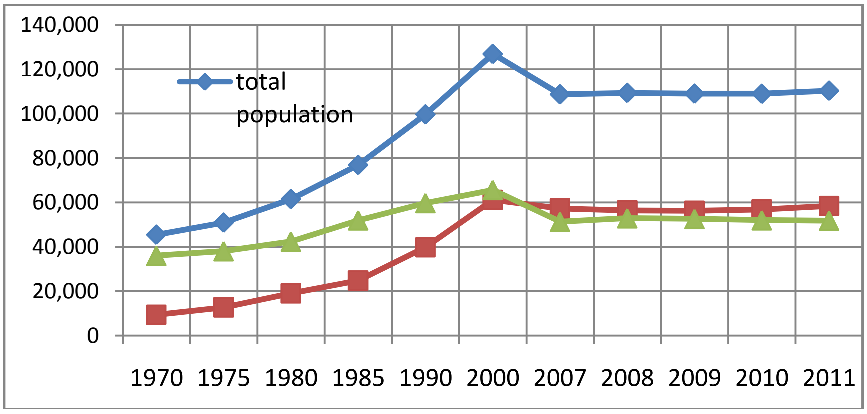


Figure 2. Bismil District Population Changes by years(TUIK 2013)

2.2 Methods

In the study, 316 wells drilled by public institutions such as DSİ, District Governorships, Special Provincial Administration, as well as private persons for watering purposes between the years 1996-2011 have been examined. The drilling data was ranked with the aid of Microsoft Excel software, and the coordinates have been arrangedaccordingly. These data was run on the ARC Map software. The data that havebeen converted to Shape (shp) format havebeen modelled through Spatial analyse. In the followingmaps, a basemap has been prepared through "Open Street Maps and Contributes" found under the Arc Info software. UTM Datum 1950 37 has been used as projection. Static water level maps relevantto the years 1996-2000 (Figure 2), 2001-2004 (Figure 3), 2005-2008 (Figure 4), and 2009-2011 (Figure 5) have been obtained through all these processes.
Changes in the groundwater levelsrelevantto the nominatedyears have been detected usingthese maps. The settlement examples and groundwater graphic changes of the Bismil districtand its villages have been drawn (figures 7, 8 and 9) with these maps. In the light of this data, results have been obtained. Otherwise all term of groundwater changes raster data had been analysed with spatial analyst Local cell statistics menu. Results figure shows in figure 13.

III. RESULTS

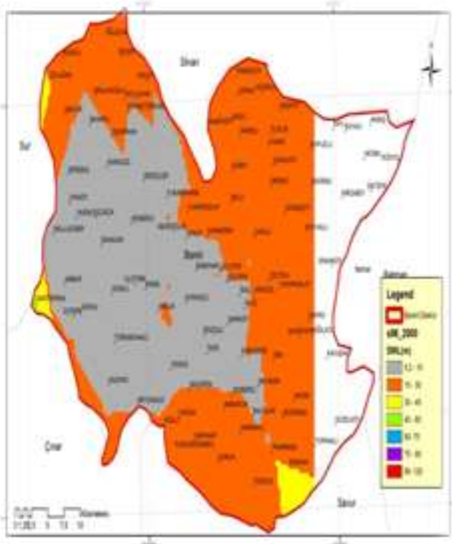


Figure 3. 1996-2000 years Tigris Bismil level map

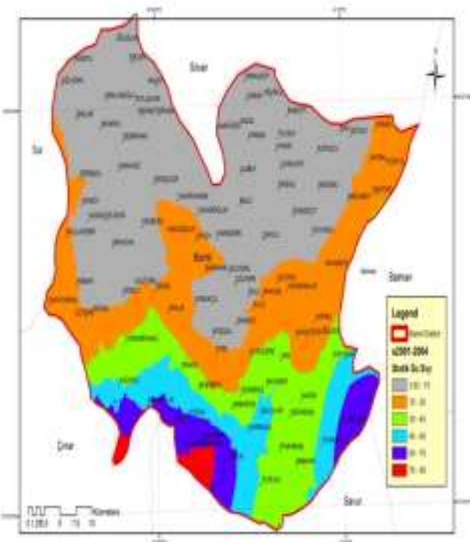


Figure 4. 2001-2004 years Tigris Bismil Basin Basinstatic water static water level map

Figure 5. 2005-2008 years Tigris Bismil level map

Figure 6. 2009-2011 years Tigris Bismil Basinstatic water static water level map

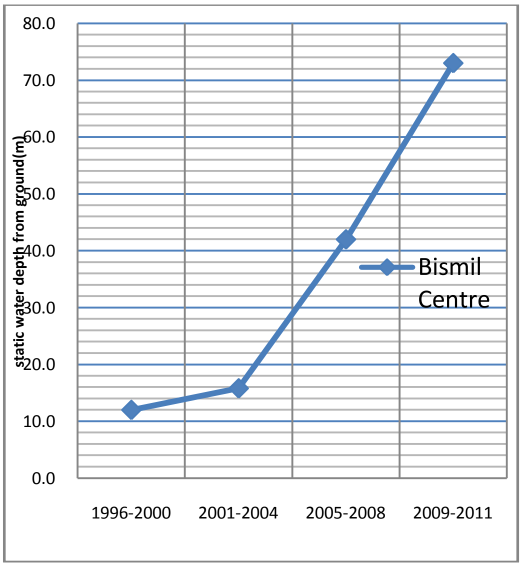


Figure 7. Bismil Centre SWL changes

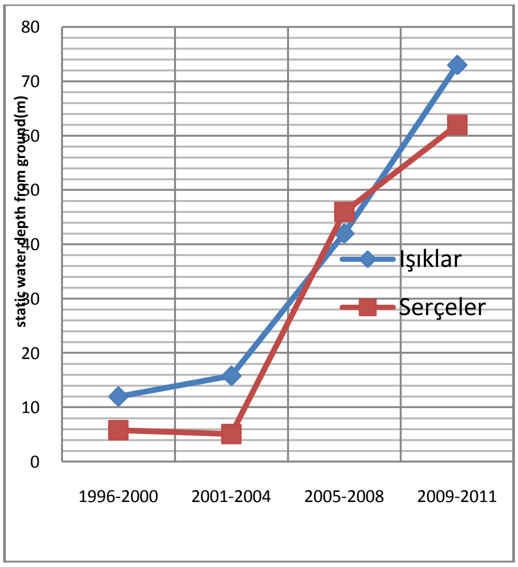


Figure 8. North-West Region SWL changes

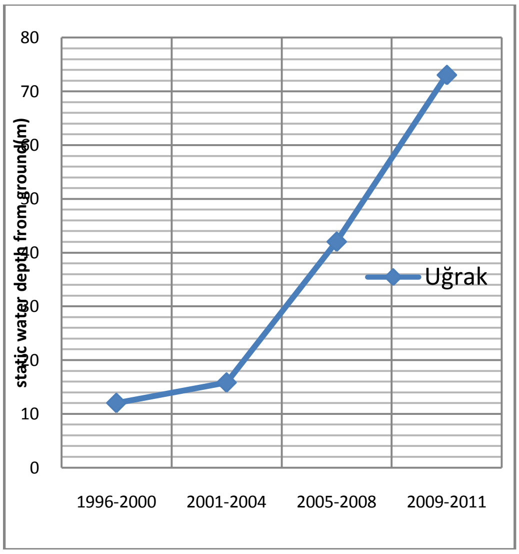


Figure 9. Bismil North Region SWL changes

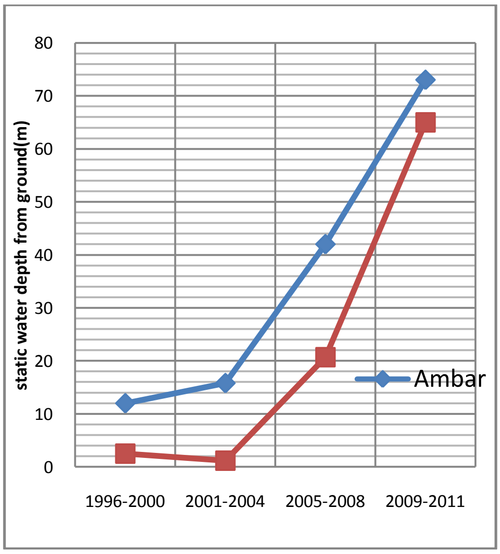
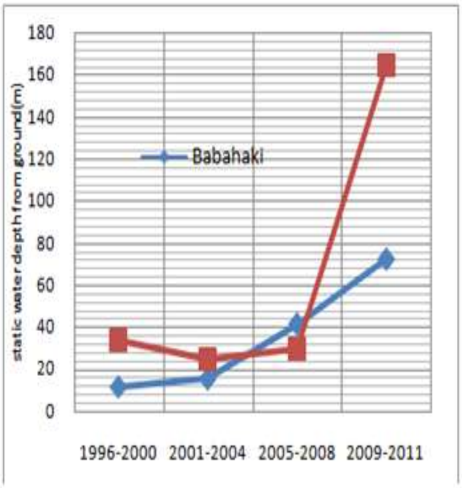


Figure 10. Bismil West Region SWL(changes)



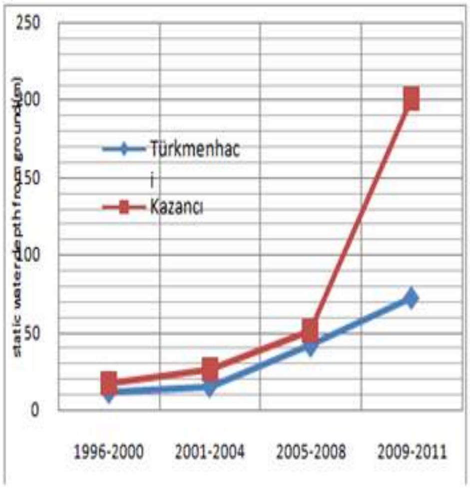


Figure 11. Bismil South-East Region SWL changes **Figure 12.** Bismil South-East Region SWL changes

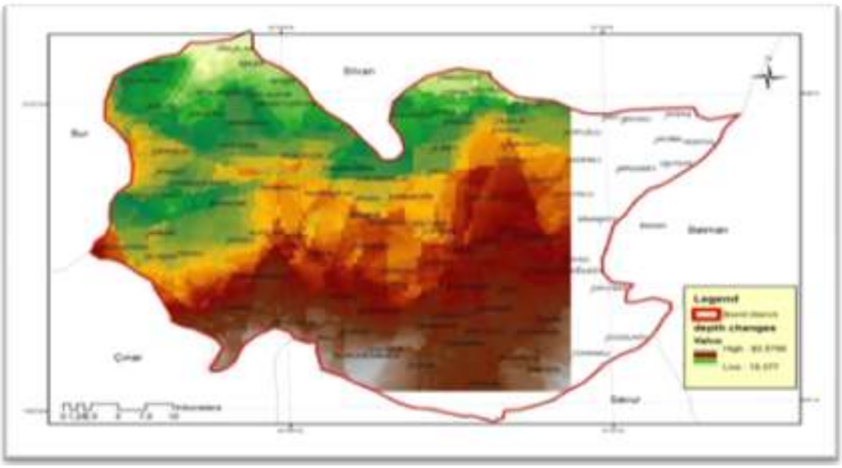


Figure 13. Bismil 1996-2001 terms mean SWL value changes

Following conclusions have been obtained from thematic maps groundwater changes are classified relevant to urban centre (Figure 7), North-West(Figure 8), North (Figure 9), West(Figure 10), South, South-East, East and South West region.

1. The groundwater levels in all other regions show a significant dropped. Even though it is known that groundwater levels havesome small seasonal changes.
2. In the Bismil settlement area the static water levels have dropped by over 55-60 meters. Especially after the year 2005, the groundwater levels have started todecrease increasingly. For example, in the Türkmenhacivillage it has dropped from 4.8 meters in 1996-2000 to 15.1 meters the years between 2001-2004.It has further dropped from 47 meters between 2005-2008 down to 103 meters between 2009-2011. Such changes are alsofound in other areas of thesettlement as well. The main reasons for thiswere theinsufficient precipitation during the years 2009-2011, and the use of thegroundwaterresourcesmore thantheir feeding. It can also be claimed that the unauthorized water wells drilled in the area have an importanteffect on these dramaticchanges in groundwater levels.The groundwater level in Central Bismilthat was at 12 meters between the years1996-2000 decreased up to 73 meters betweenthe years 2009-2011.The groundwater level in Işıklarvillage was 17 meters between the years1996-2000 has gone down to 73 meters between the years2009-2011.
3. From the 2000 years, rural and urban population of Bismil is steadily. Whereas as seen Figure 7-12 groundwater level change is decreased after 2005-2008 period sharply. So effect of population growth on groundwater is little.
4. In Bismil region, 60,000 decares of cotton, 2,500 decares of tobacco are cultivated (TUIK 2011). These crops needs more water. Besides, production of other field crops also carried out using groundwater. That would be main effect of groundwater level decrease.According to DVCSIM 2013 report, In Bismil groundwater used 0,92 hm^3/years water for drinking, 85.47 hm^3/year water for irrigation. While it seeding

groundwater average is 31,25 hm^3/year. There is huge negative budge about groundwater consumption and seeding. That would be main reason groundwater decrease.

IV. CONCLUSIONS

Groundwater level dropped average 50-60 meters in Bismil central, Northern and Western Region. South, southwest and south-eastern regions of the groundwater static level dropped average 82 m (figure 13). This change occurred especially after 2005 years. There would be main 3 factor effect the groundwater change; population growth, climate effect on precipitation and groundwater use for irrigation unconscious. Population and climate effect is very lowrather thangroundwater using for irrigation effect. So that the main reason of groundwater level decrease is using water for irrigation unconscious in the semi arid region. Suggestions:In the agricultural area groundwater use is must be under control. The using groundwater must be reducing at least %70 for irrigation in the Bismil plain. Additionally special wateringprojects (GAP Projects) should be executed as soon as possible. The need to use groundwater resources should be eliminated. In this manner the groundwater resources can reach at abalanced acceptable levelby thetimepasses.

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