

PAPER • OPEN ACCESS

Environmental Effects of Petroleum Leaks Around Diyarbakir City (SE Anatolia of Turkey) and Its Environment

To cite this article: Tahsin Aba and Orhan Kavak 2019 *IOP Conf. Ser.: Earth Environ. Sci.* **221**
012041

You may also like

- [The possible usability of three-dimensional cone beam computed dental tomography in dental research](#)
I Yavuz, M F Rizal and B Kiswanjaya
- [A Preliminary study on material properties of the Zerzevan Castle, Turkey](#)
F Dursun and A Cokun
- [Sb doping influence on structural properties of ZnO thin films](#)
Ömer Çelik, İlan Baturay and Yusuf Selim Ocak

View the [article online](#) for updates and enhancements.

ECS
The
Electrochemical
Society
Advancing solid state &
electrochemical science & technology

DISCOVER
how sustainability
intersects with
electrochemistry & solid
state science research

Environmental Effects of Petroleum Leaks Around Diyarbakir City (SE Anatolia of Turkey) and Its Environment

Tahsin Aba¹, Orhan Kavak^{2,3}

¹ Agriculture and Forestry Directorate, Diyarbakır, Turkey

² Dicle University, Institute of Science, Division of Mining Engineering, Diyarbakır, Turkey

³ Dicle University Faculty of Engineering, Department of Mining Engineering
Division of General Geology Diyarbakır, Turkey

kavakorhan@gmail.com

Abstract. Petroleum, a type of fossil fuels, is made up of the words "petra" meaning stone in Latin and "oleum" meaning oil (Petra oleum = Petrol) and it is Petroleum in English. Due to the growing population in the world, dependence on oil continues despite the search for clean and sustainable alternative energy sources. Just like all fossil-based energy sources, it is a fact that the use of oil causes air pollution, indirectly pollution of land and water resources, and the most important problem of today, global warming. Oil spills are one of the causes of this pollution. Natural and artificial oil spills cause oil pollution and cause damage that is difficult to recycle in the environment. Petroleum poses a serious risk to water resources in the pre-use phase. In this study; it will be investigated whether there is any pollutant effect on the fresh water resources in the pre-use stages of oil exploration, production, transportation, processing and storage. As a research area, Diyarbakır Province, which is located in the north of the Upper Mesopotamian Basin, where all phases (systems) before use such as exploration, production, transmission, storage and treatment (refining) are found altogether. Almost all of the oil production in Turkey is provided from the South-eastern Anatolia Region. With daily crude oil production, Diyarbakır is the second largest producer of crude oil after Batman. In Diyarbakır province there are 42 Oil Fields operated by various oil producers and over 260 Oil Wells are located in these fields. In the scope of this study; In Diyarbakır province, active or inactive oil fields and their locations will be determined and their impact areas will be determined. Underground and surface water resources (existing wells, streams and natural and artificial lakes) being in the impact area will be identified and their locations will be processed on the map. Samples will be taken from the water sources along with the field study. Physical and chemical analyzes of the samples will be performed. In this context, it will be investigated whether there are any petroleum components in the water resources and in what stage and where the pollution before the consumption occurs.

1. Introduction

Fossil fuels, also known as hydrocarbons, are found in gas, liquid and solid state. Petroleum, a liquid form of fossil fuels, is made up of the words "petra" meaning "stone" in Latin and "oleum" meaning oil. It chemically contains mostly carbon and hydrogen, and also few amount of oxygen, nitrogen, sulphur, vanadium and nickel components.



Dependence on oil continues despite the search for clean and sustainable alternative energy sources due to the growing population in the world. Like all fossil-based energy sources, it is a fact that the use of petroleum also leads to air pollution, indirect pollution of land and water resources, and the most important problem of today, global warming. Oil spills one of the causes of this pollution and could cause an irreversible damage on the environment.

The oil spills can be separated into two groups as natural and artificial oil spills. In the literature on natural oil spills, various formation mechanisms are mentioned, but overall, they are the oil flowing up through the geological formations and reaching the surface finally. The artificial oil spills are the leaks that develop as a result of the separation of the petroleum produced during and after the production of the petroleum, the leaks that occur during transportation through the pipelines and marine tankers of the oil, and the leaks that occur when the petroleum is kept in tanks in the storage areas [1].

In this study; it will be investigated whether there exists any pollutant effect on the fresh water resources in the stages of oil exploration, production, transportation, processing and storage. Diyarbakir Province of Turkey's South-eastern Anatolia Region was selected as the research area related to study since it contains all of the stages of oil before it becomes the end product; exploration, production, transportation, storage and processing.

Almost all of the oil production in Turkey is provided from the South-eastern Anatolia Region. With daily crude oil production, Diyarbakir is the second largest producer of crude oil after Batman. In Diyarbakir province there are 42 oilfields operated by various oil producers and over 260 oil wells are located in these fields [2]. As shown in Table 1, active wells are not present in some areas and are shown as zero (Table 1). Figure 1 shows roughly the areas of oil fields in Diyarbakir Province (Fig.1).

Table 1. Oil Fields in Diyarbakir City (0* non production)

District	Field Name	Number of the Oil Wells in the Field
Bismil	Kastel	8
Çınar	Altınakar	0*
	Başaklı	0*
Eğil	Güney Sarıcak	17
	Malatepe	22
	Doğu Yatır	6
	Yatır	2
	Batı Malatepe	2
	Kurkan	31
	Baysu	6
	Güney Kurkan	2
	Karacan	7
Eğil+Yenişehir	Batı Kayaköy, Güney Kurkan, Yeşildere	33
Ergani	Hançerli	1
	Miyadin	1
	Migo	0*
	Soğuktepe	0*
	Güney Sarık	0*
Hazro	Güney Hazro, Handof, Terdöken, Yeriğüzel, Dadaş, Boliş	0*
Kayapınar	Beykan	31
Kayapınar+Yenişehir	Çıksor	0*
Kocaköy	Barbeş	15
	Katin	3
Silvan	Karaali	2

District	Field Name	Number of the Oil Wells in the Field
Sur	Bostanpınar	1
	Yeniköy	14
	Mehmetdere	1
	Kayayolu	1
	Kartaltepe	2
	Beyazçeşme	0*
Yenişehir	Güney Kayaköy	4
	Kayaköy	16
	Güney Şahaban	6
	Güney Kırtepe	13
	Karakilise	1
	Şahaban	16

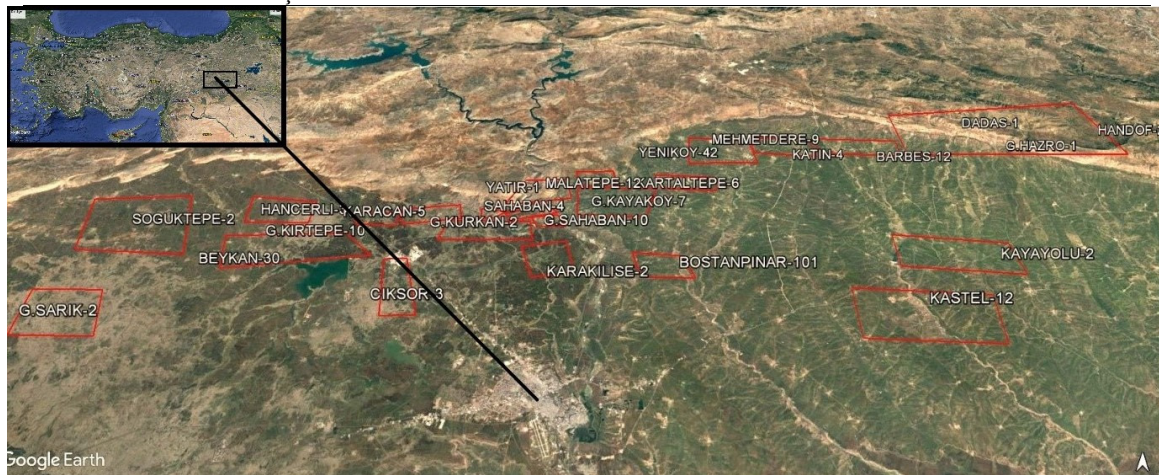


Figure 1. Oil Fields in Diyarbakır City

2. General Geology of Diyarbakır City

The Eocene aged Gaziantep formation, the Miocene aged Fırat formation, the Miocene - Pliocene aged Yeniköy formation, the Karacadağ basalts, the Quaternary aged Gölpınar formation, the Ovabağ formation and the alluvium occur on the surface in Diyarbakır province [3].

The Gaziantep Formation, with chert, silt and chalk in the base, belonging to the Eocene aged Midyat Group is exposed. The unit is unconformably overlain by the Fırat formation belonging to Silvan group in the form of reefal limestone. The Upper Miocene-Pliocene Yeniköy formation consists of conglomerate, sandstone and mudstone intercalation over Fırat formation. Yeniköy formation is unconformably overlain by the Karacadağ volcanics, Gölpınar formation, Ovabağ volcanics and the uppermost unconformable quaternary alluvium [3] (Figure 2).

3. Environmental Effects of Crude Oil

Petroleum used in different areas and facilitating life causes pollution of land, air and water during the stages of exploration, production, transportation and use. It is seen that since 1960, many petroleum accidents, which have caused pollution in large dimensions, have happened. Examples of major accidents in recent years include tanker accidents in the Gulf of Mexico, Alaska, Antarctica. It is known that compounds and aromatics with low boiling points in the structure of petroleum have a toxic effect on living organisms, while others are carcinogenic. However, the nature and size of the effect on the plants regarding the onshore oil pollution is different. The petroleum strata cover the vegetation in thin layers to prevent oxygen diffusion and prevent the oxygen from going to the plant

roots. After the plant has been green for a few days, it turns yellow and becomes unable to breathe. Petroleum affects biological activity, damages to plants, and changes the physical properties of the soil. At the same time, depending on the amount of petroleum poured into the soil structure and the oil viscosity, seepage could occur and this may result in the pollution of the underground water resources [1].

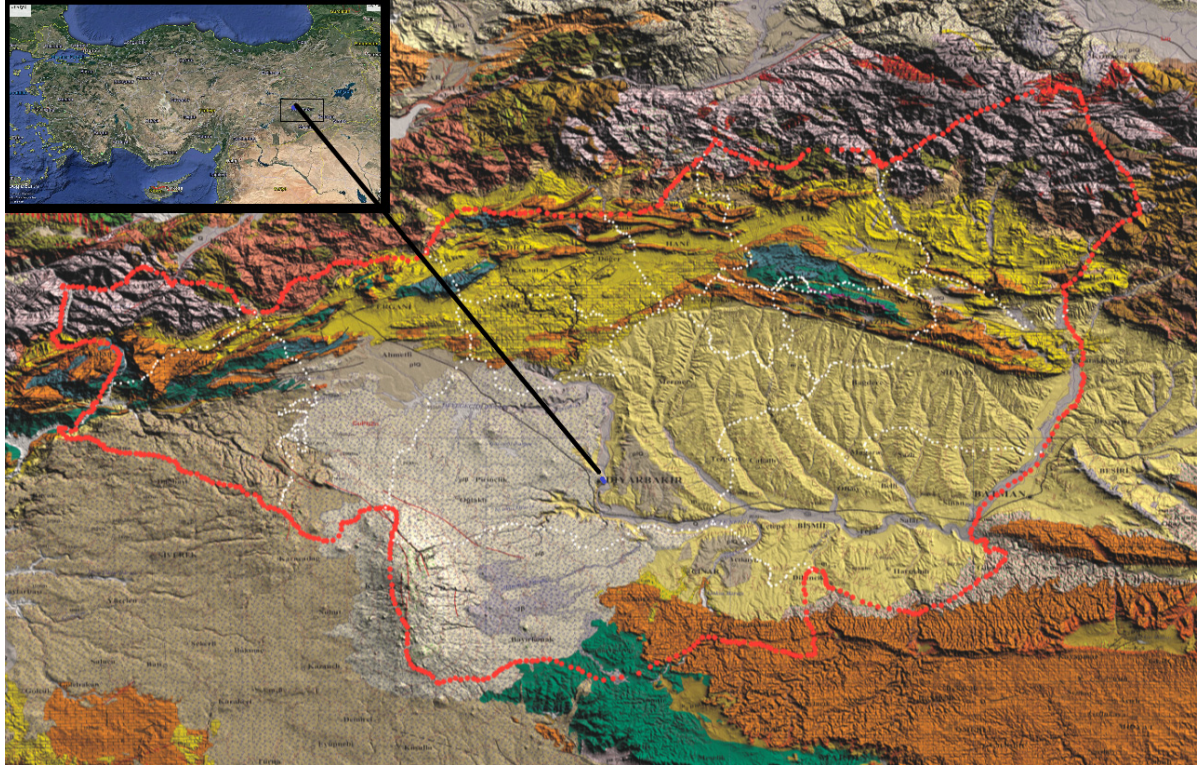


Figure 2. Diyarbakir City Geology Map

The oil drilling wastes formed during the onshore drilling are discharged to the mud pools called mud-pits. Thus, a large amount of oil-contaminated drilling waste is formed.

The salt water above and below the oil layer is brought to the surface by oil drilling and is injected back into underground after the process of separating the salt water from the crude oil. In this water, toxic substances such as salt, phenol, PAH, heavy metal can be found in considerable amount. Salt water emerges as a waste after processing of crude oil and gas, and it can contaminate underground freshwater resources by discharging it either to the surface or to underground formations by injection [4].

4. Results and discussions

The most important waste material of the oil production wells is the formation water that is produced together with the oil. The constituents of the formation water could be grouped as heavy metals, hydrocarbons, salts, radioactive substances and dissolved gases [5].

Formation waters are usually either discharged into natural water environments such as the sea or lake, or injected back to underground. The necessary treatment processes must be applied to this water before it is released. Otherwise, it is clear that this water will cause considerable underground and surface pollution and as a result of the pollution, clean water resources will be unusable [6].

Within the scope of this study; firstly the literature review on the subject was done; national and international publications and projects were evaluated. In Diyarbakır province, active or inactive oil fields and their locations are determined. The areas of influence of these oilfields have been identified. Underground and surface water resources (existing wells, rivers and natural and artificial lakes) entering the area of influence are identified and their locations are processed on the map.

In the field study, water samples were taken from streams, rivers, lakes and clean water wells near the oil wells located in oil fields (Figure 3, 4, 5, 6). These locations were indicated on the map (Figure 7). Acquired water samples were stored under appropriate conditions for analysis, and then sent to the laboratory.



Figure 3. Oil Production Well



Figure 4. Water Sampling Point (Stream)



Figure 5. Water Sampling Point (Drilling Water)



Figure 6. Water Sampling Point (River)

4.1. Results

In addition, in the research titled “Oil Pollution in Underground Water (Midyat Aquifer) around Diyarbakır” by the 10th Regional Directorate of State Hydraulic Works (DSI) [7]

Water including crude oil from Beykan, Kurkan and Şahaban petroleum fields, located approximately 30 km north and northeast of Diyarbakır city, have been started to be injected back into underground since 1971. This petroleum water injection was made in Midyat aquifer where drinking, usage and irrigation water are provided around Diyarbakır. With the emergence of this situation in 1996, the Ministry of Environment, DSI, General Directorate and Petroleum Affairs of Turkey investigated the contamination in Beykan oil field.

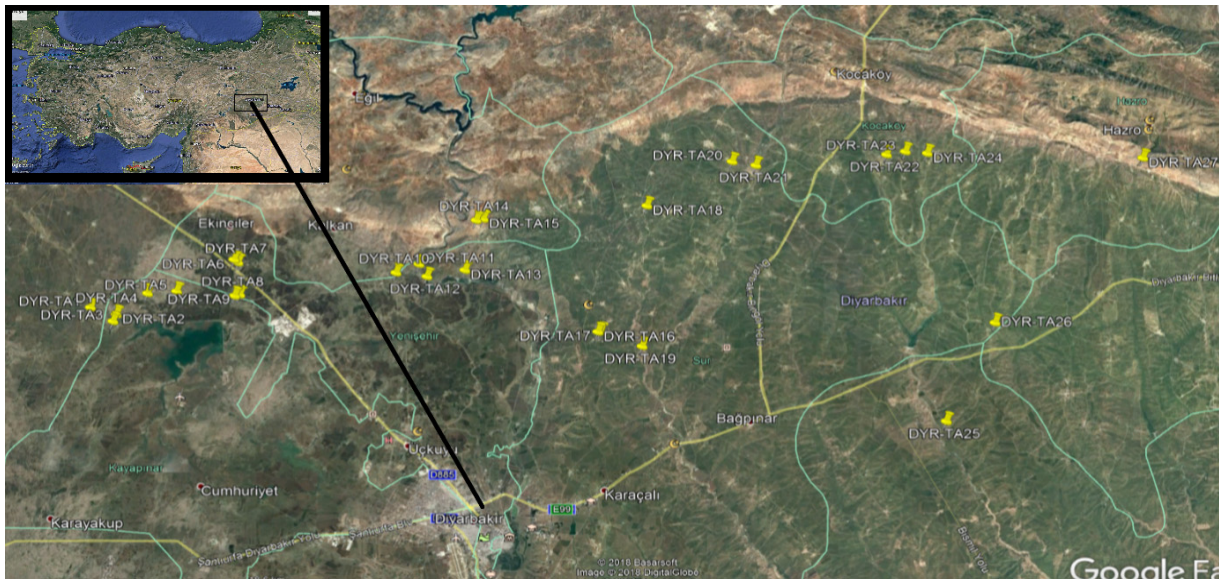


Figure 7. Satellite image of water sampling points around the oil fields in Diyarbakir Province

As a result of the studies, it was determined that $1,252 \times 10^6 \text{ m}^3$ of underground water was contaminated and the dirty water was traveling 18,7 km to Diyarbakir.

- Four water wells were drilled to determine the spread of pollution in the Beykan, Kurkan and Şahaban areas and to monitor the progress of the pollution in Diyarbakir direction.
- Physical, chemical and oil analyzes were carried out by taking water samples from wells opened for observation and 10 potable water wells around Diyarbakir.
- No pollution was found in potable water wells around Diyarbakir.
- In three out of four potable water wells drilled for observation (except Güvendere well) oil was found.

The results of heavy metal analysis of the wells opened for observation showed that Karakol Bahçesi and Güzelköy wells contained Zinc and Güvendere included manganese above TS 266 drinking water standards [7].

4.1.1. Results from DSI, oil analysis and analysis results [7]

- Less than n-C22: means that n-alkanes with a maximum of 22 carbons are present. Alkanes smaller than alkanes with 22 carbons could mean pollution from the crude oil, also could be a sign of living organisms (eg bacteria and algae).
- More than n-C22: n-alkanes containing higher carbon than 22 carbons (up to n-C29) could be detected. The distribution of these alkanes with high molecular weight resembles that of typical petroleum. These n-alkanes indicate that the petroleum source causing the oil pollution in the water is near.
- Mature sterane and hopane have been detected. These compounds are certainly derived from petroleum. Sterane and hopane compounds are densely present in the water samples taken from Observation-3 well (Table-2).

Table 2. Oil analysis doneby DSI

Sample name	Total Organic Carbon (miligram/l) (ppm)	Total PAH (mikrogram/l) (ppb)	Saturated hydrocarbons (Alcane distribution) (GC)	mature Biomarker (steran, hopan) (GC-MS)
Yaytaş	10.3	4.6	Less than n-c22 (1)	Not exist
Karakol Bahçesi	3.3	13.1	More than n-c22 (2)	exist (few) (3)
Güzelköy	34.7	0.5	Less than n-c22	Not exist
Gözlem-3	24.6	68.4	More than n-c22 (2)	exist (too much) (3)

4.1.2. Evaluation by Total Organic Carbon (TOC) Amount [7]

Karakol Bahçesi well water sample is of high quality (uncontaminated), Yaytaş well water sample is less polluted and Güzelköy and Observation-3 well water samples can be defined as very polluted.

4.1.3. Evaluation based on the amount of total polyaromatic hydrocarbon (PAH) [7]

Accordingly, samples belonging to Yaytaş, Karakol Bahçesi and Observation-3 wells can be defined as "polluted". Based on the Total Organic Carbon contents, water samples belonging to Yaytaş, Güzelköy and Gözlem-3 wells were defined as dirty water. In the case of Güzelköy well water, the total PAH content is lower than 3 ppb indicating that the hydrocarbon pollution in the sample comes from non-aromatic hydrocarbons (eg aliphatic hydrocarbons).

4.1.4. Evaluation based on Alcane and Mature Biomarker (steran and hopan) Analysis Results [7]

It can be said that there is a definite oil pollution in Karakol Bahçesi and Observation-3 well water samples. In particular, heavy oil pollution has been detected in the Observation-3 well in the Beykan field.

4.2 Proposal

Based on the results of this analysis [7]:

- Four monitoring wells were drilled to monitor the spread of petroleum pollution in Beykan, Kurkan and Shahaban oil fields and to determine the pollution.
- These wells and additional 10 potable water wells connected to Midyat aquifer around Diyarbakır were evaluated. Water samples were taken from these wells and analyzed.
- No pollution was observed in the water samples taken from drinking water wells around Diyarbakır.
- Of the water samples taken from the wells opened for observation purposes, 3 were found to include oil.
- Hydrocarbon analyzes carried out on water samples taken from the wells opened for observation showed that there was a small amount of oil pollution in the Karakol Bahçesi well. This well is located within the determined Beykan oilfield pollution limit (18.7 km).
- Extensive surveys should be conducted to investigate the extent, direction and amount of pollution in the Kurkan and Şahaban oil fields.
- Observation and analysis should be continued in order to monitor the pollution in the beykan field and to determine the pollution that may occur in Diyarbakır.

5. Conclusions

The South-eastern Anatolia Region is a region with an annual surface flow of 52.94 billion m³ and reserves of about 1.7 billion m³ of underground water. Diyarbakır province is in an important position in terms of underground water reserves and the amount of underground water determined by DSI is 0,380 billion m³. Oil exploration activities in Diyarbakır province are continuing and it is clear that the oil and water pollution risk of existing water and soil resources regarding the land or rail transport of processed or semi-processed products of produced oil is high [8, 9]. In this study, physical and chemical analyzes of water samples taken from the points of impact of oil fields will be done. In this context, it has been investigated whether there are any petroleum components in the water resources and in what stage and where the pollution before consumption arises as a result of element analysis. It was tried to identify the cause of a possible problem then to find the ways to solve the problem completely or in part. The results of the analysis will be compared with national and international acceptable limit values [8].

Acknowledgment(s)

We would like to present our gratitude to all with remarkable contributions. This study was carried out within the scope of the master thesis titled "Diyarbakır İli ve Çevresindeki Petrol Sızıntılarının Çevresel Etkileri" of the first author studying in the Division of Mining Engineering under the Institute of Science and Technology at Dicle University, and that of the projects named DÜBAP 10-MF-105" Diyarbakır İli ve Çevresindeki Petrol Sızıntılarının Çevresel Etkileri" and DÜBAP ENGINEERING.17.009 "Kullanım Öncesi Aşamalarda Petrolün Diyarbakır Su Kaynaklarına Etkileri" are carried out within the scope of the projects named.

Referanslar

- [1] O. Kavak, K. Önen, "Diyarbakır'da Petrol Ve Çevresel Etkileri", *Diyarbakır'da Tarım Doğa ve Çevre Sempozyumu*, Dicle Üniversitesi, Diyarbakır, Türkiye, 01-03 Haziran 2010.
- [2] Türkiye Petrolleri A.O., "T.P.A.O. Üretim ve Rezervuar Bilgileri", 2015.
- [3] "Dicle Alt Havzası Hidrojeoloji Nihai Raporu", *T.C. Orman ve Su İşleri Bakanlığı, Devlet Su İşleri Genel Müdürlüğü, Jeoteknik Hizmetler ve Yas Dairesi Başkanlığı*, Ankara, Türkiye, Kasım 2016.
- [4] E. Okandan, F. Gumrah, B. Demiral, "Energy Sources Taylor & Francis INC", *325 Chestnut St, Suite 800, Philadelphia, PA 19106 USA*, 23 (4), 327-336, 2001.
- [5] A. Meriçboyu, N. Yavuz, "Enerji Çevre Hukuku Ders Notları", *İTÜ Enerji Enstitüsü*, İstanbul, 2011.
- [6] M. N. Borand, "Açık ve Kapalı Maden İşletmeciliğinde Çevresel Etki", *Environmental Impact in Open and Closed Mining Operations, Doctoral thesis Istanbul Teknik Üniversitesi Fen Bilimleri Enstitüsü*, İstanbul, 2012.
- [7] T. Çelebioğlu, A.C. Parlak, "Diyarbakır Çevresinde Yeraltı Suyunda (Midyat Akiferinde) Oluşan Petrol Kirliliği", *Diyarbakır Oil Pollution in the Underground Water (Midyat Aquifer) Around Diyarbakır*, 2000 (in Turkish)
- [8] Z. F. Toprak G.Y. Bayar, O. Kavak, A. Saydut, O. Arpa, N. Hamidi, "Güneydoğu Anadolu Bölgesi'ndeki Su Kaynaklarında Petrol Kirlilik Riskinin Araştırılması", *5. Ulusal Su Mühendisliği Sempozyumu*, Investigation of Oil Pollution Risk in Water Resources in Southeastern Anatolia Güneydoğu, İstanbul, 12-16 Eylül 2011.
- [9] R. Çelik, Z.F.Toprak, "Küresel İklim Değişikliğinin Diyarbakır Kent Merkezi Yeraltı Suyu Seviyesine Etkisi", *The Effect of Global Climate Change on the Groundwater Level of Diyarbakır City Center*, 8. Ulusal Hidroloji Kongresi, 2015.