An Investigation of the Possible Effects of Oil Wells and Refineries on Landscapes: Batman Case

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Abstract— *Petroleum is a substance that mostly consists of hydrocarbons, nitrogen, sulfur, oxygen and small amounts of metal elements. This substance, extracted from underground, has a unique odor, a very intense consistency and a dark color. Throughout history, people have benefited from oil in different ways. With the processing of oil, many by-products are obtained. These by-products are used in many different areas such as transportation, medicine, accommodation, heating and clothing. The aim of this study is to evaluate the possible effects of oil extracted from underground resources on the landscape. For this purpose, Batman province was chosen as a sample area. Batman is one of the 9 provinces in the Southeastern Anatolia Region. Batman economy is based on oil, agriculture and animal husbandry. Turkey's first oil refinery is located in Batman. In the research, field observations, literature on the subject and the area and DPSIR analysis were used. DPSIR analysis is a five-stage analysis method and is used especially for the purpose of determining the situation and guiding / determining the direction of decision makers in environmental issues. It is among the results obtained that the primary environmental problem of Batman province is air pollution, one of the reasons may be one of the oil exploration / extraction / processing activities in the region and this situation plays an important role on the ecological balance, especially human health.*

Keywords— *Batman, DPSIR, Landscape, Oil Refinery, Oil Well.*

I. INTRODUCTION

The word oil is derived from the Latin words "petra" and "oleum". Here, petra means stone, and oleum means oil. Petroleum is a mineral oil extracted from underground, with a denser consistency than water, containing hydrocarbons, dark colored and unrefined, fragrant, naturally flammable (Hız, 2015).

Oil is a substance used in daily life for many purposes throughout human history. Although it did not have a commercial value in the early days, it was used in various fields, and oil was frequently used in construction, medicine, and especially in the production of war materials (Saltıkgil 1970, Ilgar 2018). Oil, which was used as a raw material even in the years before Christ, started to be used in homes in the areas of lighting and heating with the development of technology. The industrial revolution has been one of the biggest factors in increase in value of oil day by day, and petroleum has been used as fuel in

automobiles developed in this period (Türsan 1972, Ilgar 2018). Today, oil is a substance used in almost all areas and all sectors. The Canadian scientist Abraham Gesner refined oil in the late 19th century to obtain kerosene, which led to the emergence of the oil industry. Until the 1900s, the US state of Pennsylvania was a major power in the oil industry, but as a result of the exploration studies carried out in the following periods, new competitors emerged in different parts of the world (Hız, 2015).

Oil exploration studies in our country started in 1930s. As a result of the researches, the Raman-1 well was drilled in Batman Raman in 1940. In economic terms, earning income from oil was realized in 1948 when the Raman-8 well was drilled (Batman Governorship, 2019). As of 2020, 4 oil refinery in Turkey (Izmit, Izmir, Kirikkale, Batman) are available. Between the years of 1934-2018, there are a total of 4,944 oil wells, 1,987 of which are exploration, 2,036 of which are production and 921 of which are detected (Anonymous, 2020). Although oil is an

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uninterrupted energy source, is used almost in all areas of daily life and is effective in the power balance of countries, there are also some negative effects that create pressure on the landscape. There are national or international laws and regulations in order to minimize these negative effects. One of these regulations is the Environmental Impact Assessment Regulation in our country. It has become mandatory to obtain permission for the activities to be carried out in the field of petroleum within the framework of the Regulation.

The aim of this study is to evaluate the possible effects of oil extracted from underground resources on the landscape. For this purpose, Batman province was chosen as a sample area.

II.   MATERIALS AND METHODS

The main material of the study consists of oil wells and refinery in Batman province. Batman is one of the 9 provinces in the Southeastern Anatolia Region of our country (Fig. 1). It is surrounded by the provinces of Muş

to the north, Diyarbakır to the west, Bitlis and Siirt to the east and Mardin to the south.

Batman province generally has a mountainous and rugged terrain character in the south, north and northeast directions. The average altitude of the province is 550 m and the most important rivers are the Tigris River, Batman, Sason, Kayser, Garzan and Pisiyar streams. In the province where the continental climate is observed, summers are hot and dry, and winters are cool and rainy (Batman Governorship, 2019).

Batman economy is based on oil, agriculture and animal husbandry. Especially with the discovery and extraction of petroleum, a rapid urban process started, the city of Batman has shown an ongoing change and development, increasing from year to year. As of 2019, there are 22 oil fields, 727 oil wells and 1 oil refinery throughout the province.

Batman Petrol Refinery (Fig. 2) is the first oil refinery of our country and started its operations in 1955.
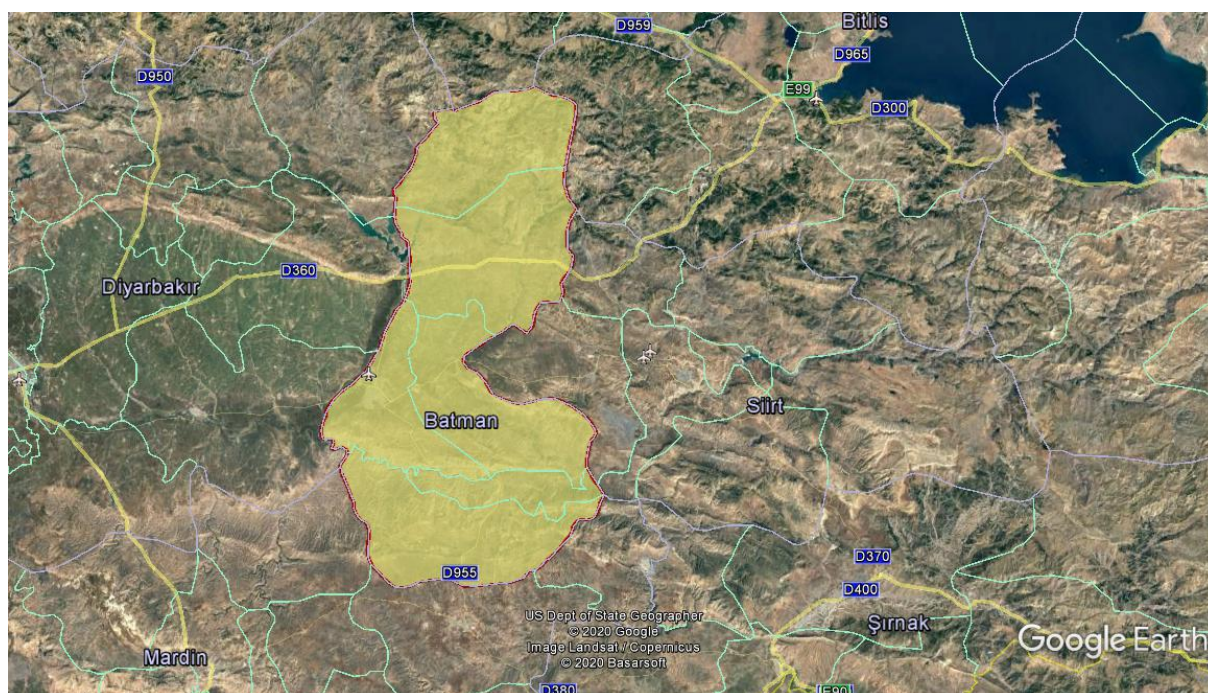

Fig. 1: Batman province location (Google Earth, 2020)

The study consists of three stages. In the first stage, related studies, reports, theses etc. were examined by making literature reviews related to the subject. In the second stage, DPSIR analysis was conducted in order to determine the possible effects of the oil refinery located in Batman

province on the city landscape. In the third and last stage, the data obtained and the field observations were evaluated, the results were presented and recommendations were made.

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The DPSIR method was developed by the European Environment Agency (EEA) in 1999 for efficient management of resources and reporting of environmental assessments (Giupponi 2002, Tavşan 2008). DPSIR is an evaluation system consisting of 5 parts, which was created in order to identify environmental issues and problems, and to identify solutions and ways to follow (Agyemang et al. 2007, Tavşan 2008). By using this method, it is ensured that the relations between human activities and the environment are formulated (Giupponi 2002, Tavşan 2008). DPSIR is considered as an intermediary that is created by combining political and scientific tools and provides communication between these tools (Vázquez and Mattei 2003). In other words, DPSIR is used to show decision makers the effects of political choices on the environment, provide feedback and provide information about the future (Kristensen, 2004).

Fig. 2: Location of Batman Oil Refinery (Google Earth, 2020)

DPSIR consists of Driving Forces - Pressures - State - Impact - Responses factors. According to the DSPIR method, there are "effective factors" (economic sectors, human activities, etc.) on ecosystems, human health and functions. These cause "situation" (physical, chemical, biological, etc.) and "impacts" through "pressures" (emissions, pollution, etc.). Thus, a chain of links that reach political "reactions" (prioritization, target settings, indicators, etc.) is formed (Kristensen, 2004) (Fig. 3).
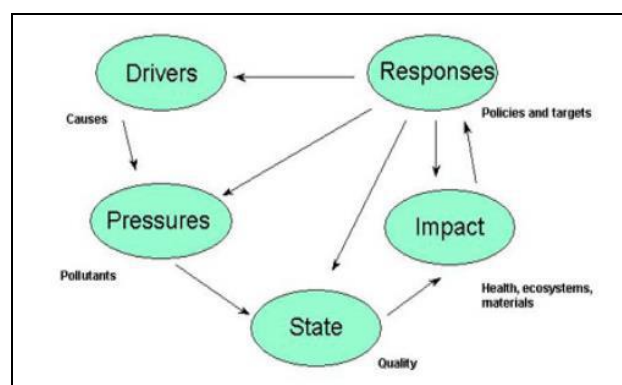

Fig. 3: DPSIR model (Kristensen, 2004)

A driving force is a need that includes social, demographic and economic production and consumption activities (Shah 2000). For example, population (numerical data, age groups structure, education level,

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political stability ...), transportation (people, goods; road, sea, airline ...), energy use (energy factors according to activity types, fuel types, technology …), power plants (type of power plant, age groups structure, fuel types ...), industry (type of facility, age groups structure, resource types ...), petroleum refineries / mining (type of facility / mine, age group structure ...), agriculture (animal number, crop types, barns, fertilizers ...), landfill (type, age ...), sewage system (types ...), non-industrial sectors, land use (Kristensen, 2004). Pressures refer to environmental pressures caused by production or consumption activities. Excessive use of environmental resources, land use changes, air-water and soil emissions (chemicals, waste, radiation, noise…), waste generation, noise, radiation, vibration, risks can be given as examples (Kristensen, 2004). Pressures affect the environment and a situation

arises. This situation is a combination of physical, chemical and biological. For example, air quality (national, regional, local, urban, etc. ...), water quality (rivers, lakes, seas, coastal areas, groundwater ...), soil quality (national, local, natural areas, agricultural areas ...), ecosystems (biological diversity, vegetation, soil organisms, aquatic organisms…), people (human health…), land use etc. (Kristensen, 2004). Multi-directional changes in the environment and emerging situations can cause environmental or economic effects on the functioning of ecosystems, human health and economic and social performance of society. Social and ecological reactions occur as a result of the effects. Reactions can affect any part of the chain between active factors and effects (Kristensen, 2004). Fig. 4 contains some examples of DPSIR factors.
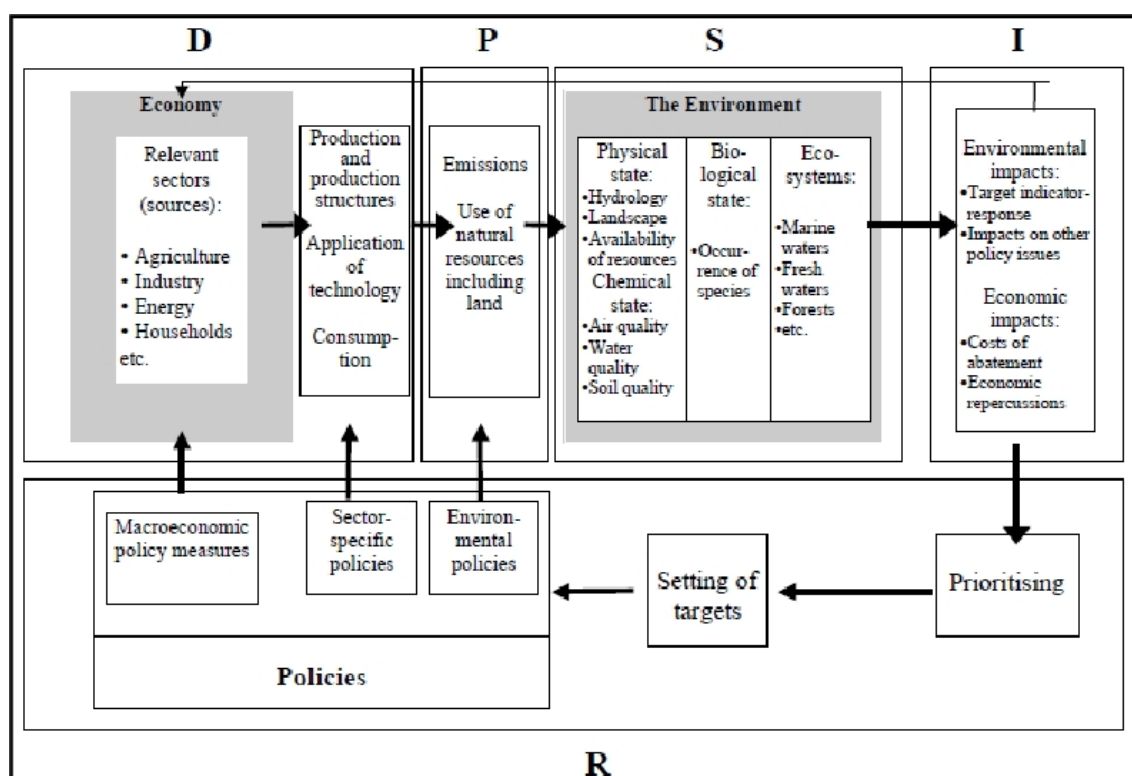

Fig. 4: Example of DPSIR factors (Kristensen, 2004)

III. RESULTS AND DISCUSSION

3.1. Environmental impacts of oil and oil refineries

Petroleum takes the name hydrocarbon together with natural gas and is available in solid, liquid or plastic form. While oil is in the gas form underground, it cools down when it comes to the surface and thus turns into condensed

oil form. Hydrocarbon in liquid form is called crude oil (Hız, 2015). The transformation of crude oil into consumer products through economic processes is the petroleum refining process. Various products such as propane, butane, LPG, gasoline, jet fuel, kerosene, diesel, mineral oil and solvents, paraffin wax, light-medium-heavy fuel oil, asphalt, coke and sulfur are produced in petroleum

refining (Dindar 2014). The places where crude oil is extracted are oil wells and where it is processed and transformed into various products are oil refineries. There are basic units in a refinery. These are process furnaces, steam boilers, gas burning (flare) systems, sulfur recovery units, fluid catalytic cracking (FCC) unit, storage facilities, fuel / water separation unit, chimney systems (Anonymous, 2017). Oil refining takes place in a five-step process. These are parsing operations, transformation operations, processing, blending and merge operations (Anonymous, 2017). There are certain environmental impacts on the landscape and public health during the establishment, operation and closing processes of oil wells and refineries and during oil refining processes (Table 1).

Table 1.: Environmental impacts of a refinery during the establishment, operation and closing process (Tabulated from Anonymous, 2017)

PRE-CONSTRUCTION AND CONSTRUCTION PROCESS		OPERATION PHASE	CLOSING / AFTER OPERATION
Noise and vibration	• Noise from infrastructure construction • Noise from traffic generated by construction activities • Vibration caused by the use of machinery		• The noise made by the machines used in demolition • Noise from traffic generated by closing activities • The vibration of the machines used in demolition
Air pollution	• Dust emission from excavation activities • Pollutant emissions from construction machinery and traffic	• Equipment leaks • High temperature combustion processes in production • Heating of steam and process fluids • Transfer of products • Dust / particulate matter • Gas emissions	• Dust emission • Emission of pollutants (NOx, suspended solids, etc.) from machines used in demolition
Wastes	• Excavation material • Non-hazardous solid wastes • Hazardous waste		• Non-hazardous waste generation • Hazardous waste • Excavation soil contaminated as a result of previous activities
Soil	• Temporary land use and occupation • Permanent land use, loss of quality soil • Erosion • Soil contamination	• Sedimentary waste contaminating the soil through leakage or transport • Soil contamination as a result of condensation in aboveground storage tanks • Spills / leaks at the refinery site that currently need to be cleaned during past production activities	• The emergence of soil pollution caused by previous activities such as production, etc. • Soil pollution caused by accident or machine failure during shutdown activities

Water pollution	• Sewage water from construction site facilities • Dirty water accumulating in foundation pits	• Leakage to groundwater in the disposal of waste water produced in some facilities • Contamination of surface waters, soil and groundwater due to possible raw material or product leakage or release • Equipment leaks and spills and waste water released during the refining process • Sulfides, ammonia, suspended solids and other compounds that may be present in oily waste water, oil residues and waste water, • Serious pollution from past discharges continues to remain in surface waters • Damage to tanks due to increased waste water corrosion in tanks • Contamination on water surfaces due to wastewater discharge	• Domestic liquid wastes from the construction site facility to be established during the closing activities
Flora and fauna, ecosystems, protected areas	• Impact on flora and fauna (depending on local situation) • Impact on ecosystems (depending on local situation) • Impact on protected areas (depending on local situation)		
Waste		• Site pollution from hazardous waste • Pollution of water resources	
Other effects (e.g. smell, sound, vibration, etc.)		• Increased transport and traffic activities due to the operation of the refinery, increase in noise levels in nearby settlements • Employee exposure to high noise levels • Effects of noise emitted from refineries on humans and animals • Odor emissions from refineries • Vibration • Accidental fires, explosions, chemical leaks and gas leaks in refinery facilities • Refineries' effects on the climate as a result of greenhouse gas emissions • Since refinery facilities are generally large physical structures that change the landscape of	

		the area where they are established, visual impacts depending on the size and quantity of the units in the refinery plant.	
Energy consumption		• A large amount of energy is consumed during the operation phase of oil refineries.	
Water Consumption		• In oil refineries, there is a high amount of water consumption during the operation phase.	
Raw material consumption		• Large amount of raw material consumption during production	

3.2. DPSIR analysis of oil wells and oil refinery in Batman province

Possible impacts of oil wells and oil refinery located in Batman province on the landscape are examined by DPSIR method and presented in Table 2. Here, the impact and response steps are combined in one step.

Oil and oil production mean a lot for Batman province. The provincial economy is based on oil and agriculture. There are oil wells in different points and districts of the province and today there is an oil refinery in the city

center as a result of urban development. Oil exploration and well drilling activities continue in the region. For this

reason, both previously opened and currently active wells and refinery and new potential wells cause land demand. The use of natural resources during oil processing is another pressure factor. As a result of these pressures and due to the steps in the petroleum processing process, intensive use of energy, use of underground and surface resources reveal, the use of water resources and necessary raw materials. All these reasons have resulted in changing / transforming the landscape characteristics of well and refinery lands.

Table 2. Possible impacts of oil wells and oil refinery in Batman province on landscape

Driving Force	Pressure	State	Impact - Response
• Oil production (Exploration/ extraction/ processing)	• Use of natural resources • Need of land	• Use of underground/surface resources • Land use • Land transformation • Use of raw materials • Intensive energy use	• Pollution of water resources • Decrease in air quality • Soil degradation • Ecosystem damage • Negative impact on human health • Consumption of natural resources • Negative impact on flora and fauna

Oil and oil production mean a lot for Batman province. The provincial economy is based on oil and agriculture. There are oil wells in different points and districts of the province and today there is an oil refinery in the city center as a result of urban development. Oil exploration and well drilling activities continue in the region. For this reason, both previously opened and currently active wells and refinery and new potential wells cause land demand. The use of natural resources during oil processing is another pressure factor. As a result of these pressures and due to the steps in the petroleum processing process, intensive

use of energy, use of underground and surface resources reveal, the use of water resources and necessary raw materials. All these reasons have resulted in changing / transforming the landscape characteristics of well and refinery lands.

In Batman province, air pollution is experienced at increasing or decreasing rates throughout the year. According to Batman Governorship (2018), air pollution is caused by cheap fuels used for heating, industrial facilities staying in the city, burning stubble, use of motor vehicles and meteorological factors. However, it should not be

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overlooked that in addition to these factors, the amount of particles in the air, the amount of suspended matter in the air, and the intense oil odor are a factor in air pollution. Although the refinery has 2 filtered chimneys, due to the reasons listed above, it is of great importance to increase inspections and make the necessary measurements more frequently and at regular intervals. The most common diseases in Batman's public are upper and lower respiratory tract infections. The primary reason for this is air pollution. According to the Assessment Report of Environmental Problems and Priorities of Turkey the factors that cause air pollution in the Batman province are as follows: Fuel used for heating purposes, petroleum industry, asphalt plants, asphalt production and storage

facilities, fuel storage and filling facilities and gypsum production facilities remaining in the city (flue gases of the fuels used in industry, residual substances thrown into the air as a result of production), meteorological factors, motor vehicles, unconscious burning of stubble. In addition, the emissions caused by the use of dung, oil, Şırnak coal, car tires, burnt oil, etc. for fuel in the winter season of people who are called slums and whose income levels are very low, deteriorate the air quality of the province considerably. In fact, because of this, people suffer from various diseases (Anonymous, 2019b). Also, according to the same report, the primary environmental problem of Batman province is air pollution (Fig. 5)
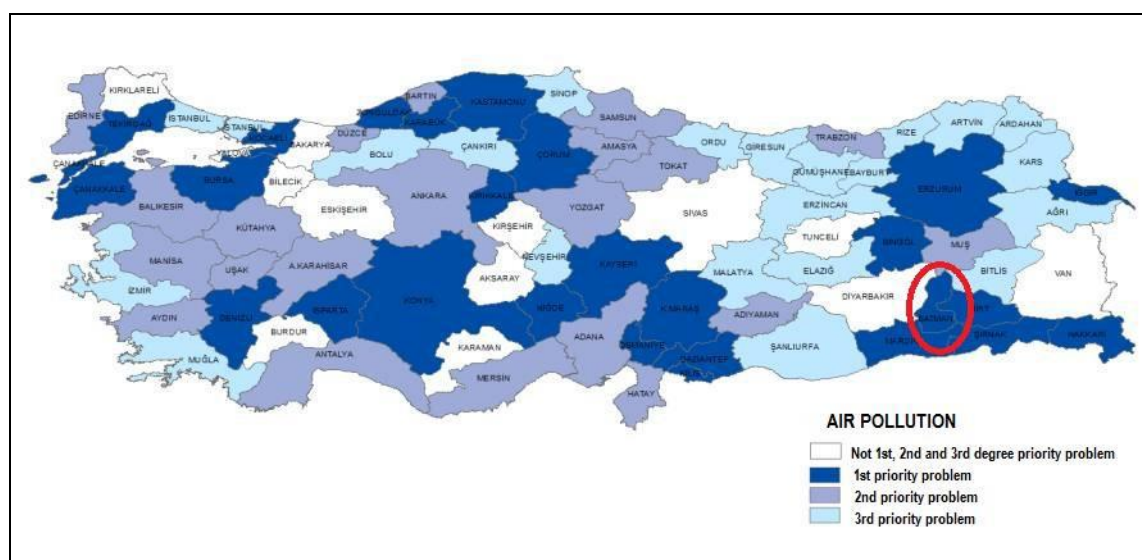

Fig. 5: Map of Turkey air pollution priority (Anonymous, 2019)

There are 2 waste water treatment plants in the Batman Refinery. One of them is used to separate industrial wastewater (generated during production) and the other to separate domestic wastewater. According to Batman Governorship (2018), surface water resources are not used for drinking and usage purposes in the province, and the water used is supplied from deep water resources. At the same time, there is no drinking water treatment facility in

the province, and chlorination process is applied to the water supplied to the network. This situation increases the possibility of wastewater to enter the water supply and poses a clear danger to human health. According to the Assessment Report of Environmental Problems and Priorities of Turkey, the second priority environmental problem in Batman province is water pollution (Fig. 6).
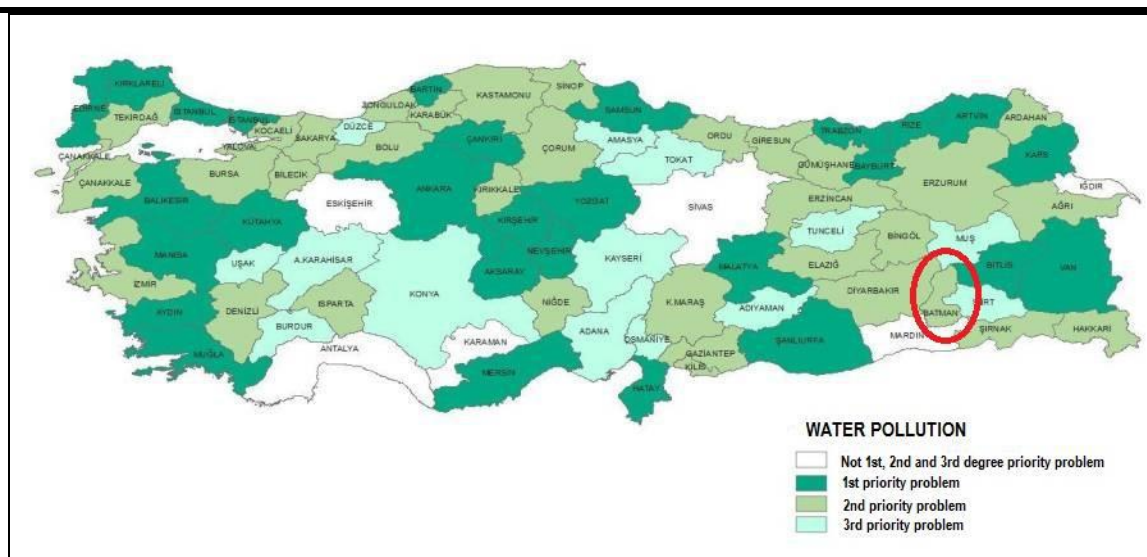
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Fig. 6: Map of Turkey water pollution priority (Anonymous, 2019)

Batman province is geographically established on the Batman Plain, surrounded by hilly and mountainous areas. With the discovery of oil, there has been a very rapid development in the urban sense. The refinery, which was located outside the city center in 1955, is now located in the city center. There are many residences and workplaces around the refinery. Considering the existence of green spaces in the city, the area where Batman Refinery is located is the largest open green area in the city center. Located right next to the refinery and called the "Site" by the public, this open green area meets the recreational needs of the people of Batman and is highly preferred. On the other hand, the fact that the refinery is now located in the city center and surrounded by urban structures increases the need for a buffer green belt around the refinery in terms of urban aesthetics and urban ecology.

IV.   CONCLUSION AND RECOMMENDATION

Oil is an energy source made up of complex organic structures. Due to its nature, oil is likely to cause environmental damage. Pollution caused by petroleum can cause danger to life, extinction of species, and pollution of underground and aboveground resources. In addition, volatile components in its content may cause fires by evaporating, thus causing the ecological balance to deteriorate. Treatment of oil-induced soil pollution is very costly and time consuming. Petroleum harms the air and water economy of the soil, reduces the adsorption capacity of the soil and causes the ion balance to deteriorate. For this reason, strict and regular inspections should be made

in oil exploration, extraction and processing fields (Dindar, 2014).

Pollutant emissions are one of the most important environmental problems in oil production facilities. Carbon, nitrogen and sulfur oxides, particulate matter from combustion, volatile organic carbons are the main pollutants. In addition, the intensive use of water for process and cooling purposes causes the water to be contaminated with petroleum products. The most intensive factors for water pollution are hydrocarbons, sulphides, ammonia and some metals (Anonymous, 2017). For this reason, filtered chimneys and treatment facilities in refineries should be checked regularly. There are few studies (Ibeanu, 2000; Etrekin et al., 2011; Sloecker et al., 2012; Ogwu 2014; Dindar 2014; Slonecker and Milheim, 2015; Hız, 2015; Madu et al., 2018; Ilgar, 2018; Medhat, 2019) on the landscape impact of oil exploration / extraction / processing structures. Such an important issue needs more scientific consideration and more research.

According to Tavşan (2008), the DPSIR approach is guiding the decision-making mechanisms, especially in the decision-making phase. At the same time, it makes important contributions to the implementation of necessary and correct measures for the protection of the landscape and the sustainability of natural resources. Therefore, decision makers need to make long-term and versatile management plans for oil production in Batman. One of the methods that can be used in preparing this management plan is DPSIR.

The economy of Batman province is based on oil, agriculture and animal husbandry. Tüpraş and Turkish

Petroleum Corporation's works in the region has enabled the industry to develop in Batman. The richest mineral reserve in Batman is oil with 2.5 billion barrels (Batman Governorship, 2018). The correct and planned management of this reserve, which is important for the province and the region, is extremely important especially in terms of preventing environmental problems.

As a result, a correct and versatile management plan is of great importance from an urban, regional and national perspective. Oil is an economically and politically powerful element. But the ecological aspect of the work should not be ignored. During the oil exploration, extraction and processing stages, the necessary inspections must be repeated correctly and at regular intervals. Situations that may disrupt the ecological balance, especially human health, cause species losses or resource pollution, in short, damage the landscape, should be eliminated.

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