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Analyzing the spatial interaction between industrial land uses and the environment using the DPSIR framework

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***Abstract*---**The spatial interaction of using industrial land and the ecosystem is characterized by its complexity and land size. While some cases show a positive impact, others have a completely negative impact on the environment. Most importantly, on several occasions, these interactions do not have a direct consequence until after an extended period of time. Therefore, in this paper, we address the framework of driving force, pressure, state, impact and the response (DPSIR) of the environmental assessment systems for sustainable development. In this paper, we also demonstrate how the electric power production affects the ecosystems. Furthermore, based on our findings in the research paper, we suggest sustainable solutions that will limit the damage caused by these interactions.

***Keywords*---**industrial land, pollutants, DPSIR framework, sustainable development, Al-Zubaydiah electricity production station.

Introduction

The growth of human requirements in various fields has generated an increasing demand for the consumption of natural resources in a very large manner. This led to regression of the environmental conditions and the emergency of many environmental problems in many places in the world [1].The multiplicity and intertwining of its causes has been accompanied by continuous urban growth in such a way that it has made changes in the ozone layer. This is also one of the main causes of the global warming phenomenon [2].

In this study, we explore the problem of ecosystem and industrial interaction based on the Drive force-Pressure-State-Impact-Response (DPSIR) framework.

During our research, we found that there is a lack of interest in environmental analysis, which guides the applications of sustainable development. In addition, neglecting the use of causal models like DPSIR is also a common issue to analyses the interaction. This shows the extent of mutual interaction between industrial land and the city environment. The research assumes that the increase in population and its activities requires the need to expand in the field of industrial land. But the unsustainable use of energy has led to several problems related to nature, humanity and the ecosystems of cities.

This study is conducted in the district of Zubaidiya, which is located north of the city of Kut, Wasit, at a distance of 75 km, and south of the capital, Baghdad, at a distance of 93 km. As for the geographical location, it is located between the longitudes (45°) and (30°) east, as for the latitude circles, it is located between the latitudes (32° 30') and (33°) in the north (Directorate of the Municipality of Zubaidiya District) [3]. Figure. 1.1 shows a detailed map of the location

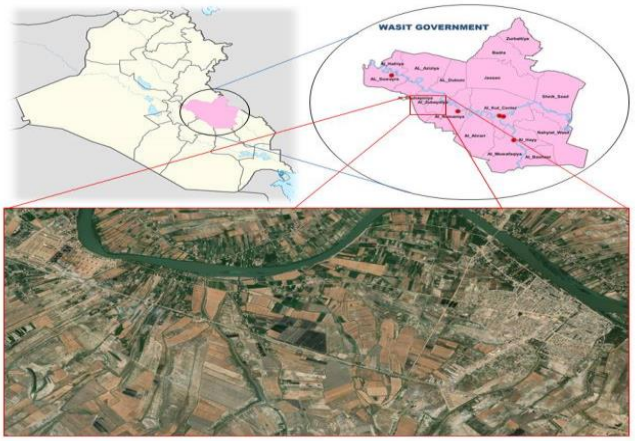

Figure 1.1: The location of the study area in relation to Iraq and Wasit Governorate. The researchers use this image based on the General Directorate of Roads and Bridges in Wasit Governorate

Figure 1.2: The location of Zubaidiya district. Researchers use SAS plant program

Zubaidiya power plant

The Chinese company 'Shanghai' worked to construct of an electric power production plant in Zubaidiya on agricultural lands adjacent to the Tigris River with an area of 830 acres (Figure.1.2) in 1998 at an estimated cost of 750 million dollars, and implementation began in 2001.But the process stopped due to the political situation in the country and then the company returned to work as the station was completed in 2014 with an initial production capacity of (1320) megawatts. The company then completed the second phase, which was a production capacity of (1220) megawatts. The station produces a total energy of (2540) megawatt-hours and transmits electrical energy in several lines (Al-Jurani, 2020, pp. 72-73):

1. Two lines for Al-Amin area in Baghdad governorate with a capacity of 800 megawatts per hour for each line.
2. Two lines for Wasit governorate center with a capacity of 300 megawatts per line per hour.
3. Another two lines for Wasit governorate center with a capacity of 100 megawatts per hour
4. Two lines for the Azizia district center with a capacity of 50 and 120 megawatts per hour

Regarding gaseous pollutants, the plant emits many gases harmful to the environment, as it produces carbon dioxide (CO2) in large quantities as a result of fuel combustion (Figure. 1.3), which in turn contributes to the process of global warming. The emitted heat from the surface of the earth is reflected and confined to the atmosphere because of this gas. Hence, Carbon monoxide (CO) is a poisonous gas as it combines with hemoglobin and causes respiratory effort and heart stroke. It is a dangerous gas and is caused by incomplete combustion. In addition to sulfur dioxide (SO2), which is one of the most polluting gases, power plants are the main source of this gas and many other gases that play a role in the deterioration of environmental systems. The station emits loud noises caused by heavy engines that are constantly running, leaving constant noise pollution. The mist is associated with smoke that accumulates on plants and homes in some nearby villages. Lead was also found to accumulate on evergreen plants in nearby villages (Al-Jourani, 2020, p. 125).

Figure 1.3: Zubaidiya power station from an aerial view

DPSIR framework and its development stages

The rapid development of growth processes on the one hand, and the exploitation of natural resources on the other hand, has led to an interest in integrating the policies of the various sectors of activities at all geographical levels to be compatible with sustainable development and environmental protection. Considering this as one of the reasons for sustainable living and ensuring human security, the policies and actions taken to provide incentives for sustainable land use, which play an effective and central role in changing land use patterns. From the perspective of sustainable development, land resources in most countries are affected by several factors and indicators such as increased population pressure, limited land area, land conversion to alternative uses, soil erosion, low fertility, loss of biodiversity and other different issues (shijin et al,2020, p3). These indicators provide an important and useful means to improve communication, transparency and effectiveness in the management of natural resources to facilitate their management and conduct the assessments and comparisons required to achieve the sustainable development goals.

The Drive force-Pressure-State-Impact-Response (DPSIR) model is based on five elements: driving force - pressures - state - impact - response as shown in Figure. 1.4. These elements appeared as indicators to begin the process of practical application of the term sustainability, which is the framework adopted by the European Environment Agency to assess and manage environmental problems in a cause-and-effect manner. DPSIR uses to develop environmental policies that reduce negative effects the impact of driving forces and address various pressures to improve the state of the environment (Hanne S et al, 2008, p116-125) [4].

The DPSIR framework also aims to determine the current state of the environment and its future trends based on recent data and indicators. It works on the basis of analyzing the relationships between human activities and ecosystems in a consultative and participatory manner. It also analyzes various factors such as: general measures of the different sectors, current environmental policies, and their repercussions on the environment, and predicts future scenarios for the state of the environment in terms of developing plans and programs.

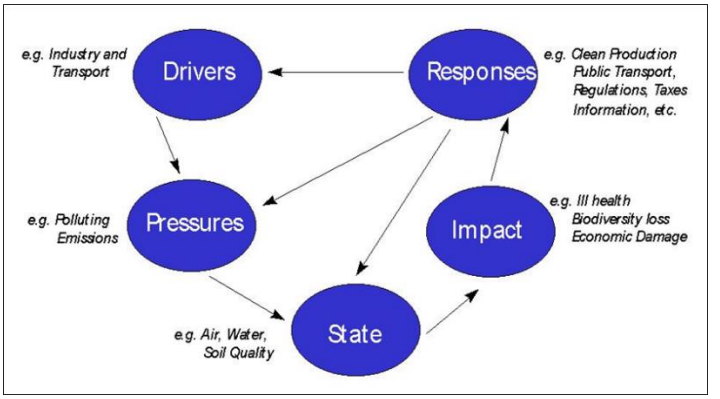

Figure 1.4: DPSIR Framework Key Concepts (Goble S and Hill M,2017 ,p 70) [5].

Thus, DPSIR contributes to monitoring the environmental situation and prioritizing plans for making environmental decisions and formulating strategies and policies. It also contributes to enhancing the means of environmental awareness by educating all individuals of society on the state of the environment in order to enhance participation in environmental decision-making. Successful implementation of the adopted environmental policies lead to more controllable cases (shijin et al, 2020) [6], as shown in Figure. 1.5. Figure. 1.5 illustrates the general structure of the DPSIR framework in analyzing the interaction between human activities and the environment.

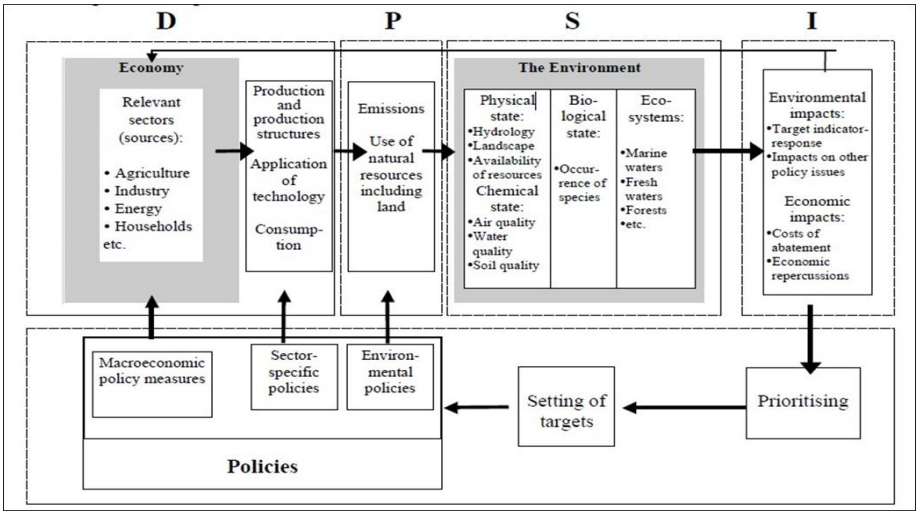

Figure 1.5: General Structural Framework of the DPSIR (Kristensen, 2004, p137) [7]

Concepts of DPSIR framework's elements

At the outset, it is necessary to define the components of the framework and what it specifically refers to, which is the basis, on which all its uses will be built and what are the possibilities for its development to suit all areas of analysis and evaluation. Figure. 1.6 shows the suitability of the framework in the analysis of urban activities (Mahsa et al, 2021, p2) [8]. There are several keywords for each component that can identify and infer the quality of the required data as follows:

- Driving force: Key words: needs, activities, motives, requirements
- Pressures: Key words: consumption, increased emissions, risks, deterioration
- State: Key words: physical, chemical, biological changes
- Impact: Key words: the effect on the quality of ecosystem services
- Response: Key words: plans, policies, laws and regulations, monitoring and controlling the environment, improving and mitigating the impact.

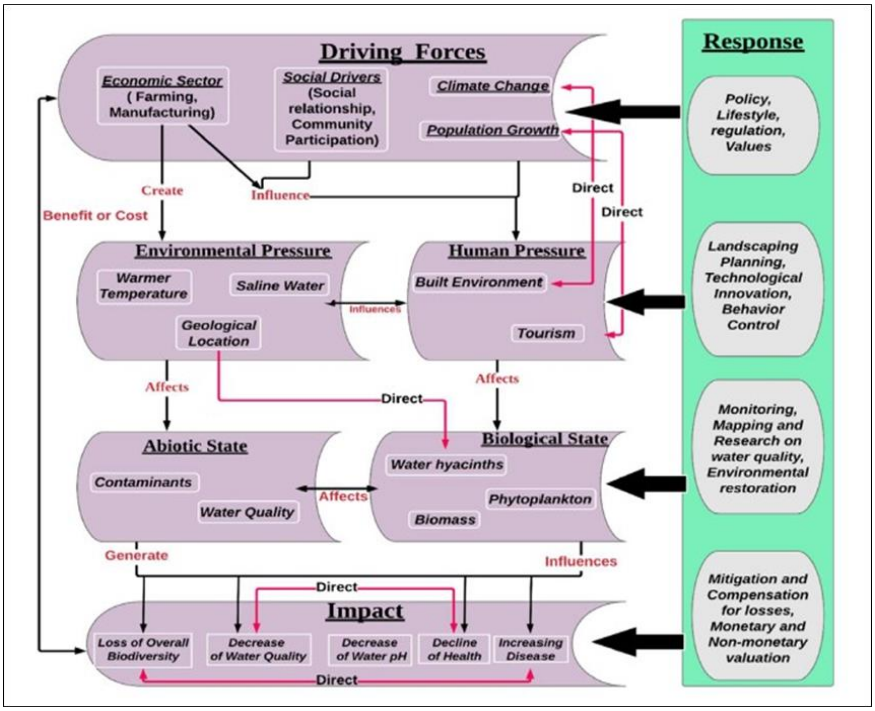

Figure 1.6: Adaptation of the DPSIR framework in urban activities (Md. Nazmul Haque et al.,2019, p51) [9].

The application of the DPSIR framework for industrial land use in the district of Zubaidiya

The uses of industrial land in the district of Zubeidiya are spatially distributed within the city center and its outer periphery. This research explores the Zubeidiya power station mainly within this use, as it has the greatest impact and a clear polluter for the environment and the surrounded regions in general.

Driving force stage

This stage includes all the driving forces that played a major role in the establishment of the electric power production station in the district of Zubaidiya, and the most important of those motives are:

1. The severe shortage of electric power production in Wasit Governorate in particular, and the neighboring governorates in general.
2. Most of the electric power production stations in the country are outdated.
3. The steady increase in consumption as a result of the population increase, which amounted to (1,415,034) residents of Wasit Governorate, with all its administrative divisions in 2021, in addition to the population served from the capital, Baghdad.
4. Increasing demand for purchasing electrical appliances and equipment.
5. Exploitation of the associated gas produced in the Badra oil field, which is estimated at (100) cubic meters / day.

6. Creating job opportunities to employ hundreds of manpower within the governorate of Wasit and the judiciary

Figure 1.7: Driving force action.

Pressures stage

All that results from the repercussions of the aforementioned driving forces fall within the pressure stage. It is clear that the Zubeidiya power plant has economic, social and environmental impacts, which will be shown in detail in the case stage, and they are represented by the following:

1. Pressure on air quality in particular and life in general.
2. Continuous demand for a main water source represented by the Tigris River, used for cooling purposes as well as for hot water disposal.
3. The need to develop transport lines for buses transporting crude oil.
4. Pressure on the natural resources represented by biological diversity in the aquatic environment, surrounding agricultural lands and plants.
5. Increasing demand to compensate residents in villages near the station as a result of their direct impact on the pollutants released.
6. Changing the city's growth trend and putting pressure on the housing market in the western neighborhoods of the city as a result of being affected by the pollutants released from the station.

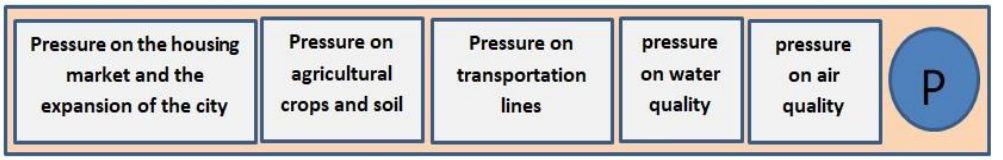

Figure 1.8: Pressures action.

State stage

All physical, biological, chemical and physical changes in the natural environment enter into this stage. At the level of changes taking place in the environment of the Tigris River, it was found that the waste water is being disposed of through dedicated pipes. The first pipe drains industrial water, and the amount of release through it ranges from 411 to 451 cubic meters per hour. The second pipe drains the hot water. The quantities of water released range from 151 to 211 cubic meters per hour. There is another pipe that takes cooling water from the river. The quantities of water through it range from 611 to 651 cubic meters per hour. The quantities of water released by the station depend on the number of operating hours of the station. This water affects many of the water properties of the Tigris River in the region. This Includes the acidity degree PH, which is one of the most important criteria for water quality Turbidity also causes a decrease in the level of

dissolved oxygen in the water In addition to the presence of many chemical elements such as sulfates, bicarbonates and chlorides, which factories and power plants are among the main sources of it, and they in turn affect the ecosystem in general and the aquatic environment in particular (Jebure, 2019) [3]. Figure. 1.9 shows a local image of the water adjacent to the station.

Figure 1.9: The reality of the water adjacent to the station.

Table 1.1: On-site examination results

points/items	Cobalt (CO)	Nickel (NI)	Lead (PB)	Cadmium (CD)	coordinates
Point1	0.821	3.50	15.04	0.182	”45 °05 ’44.7
Point2	0.747	3.24	10.42	0.175	”32 °46 ’4,14
Point3	0.582	3.07	8.01	0.127	”32 °46 ’5.8
Global standard	0.53(mg/kg)	0.2 (mg/kg)	5 (mg/kg)	0.01(mg/kg)	”32 °46 ’5.8

As for the state of plants and agricultural crops, tests were carried out at three points on three sites at different distances from the power production station. Figure. 1.10 shows these selected plant test samples site in this study. The most prominent polluting elements that affected agricultural production were measured in this study. The most important elements that exceeded the standards are cobalt (CO), and nickel (NI), which is somewhat similar to cobalt with its harmful effect and high concentrations. The elements lead and cadmium (PB and CD) were also measured, whose accumulation leads to the destruction of ecosystems and plants on a large scale. In Table 1.1, the results of the on-site examination of the above-mentioned elements are shown.

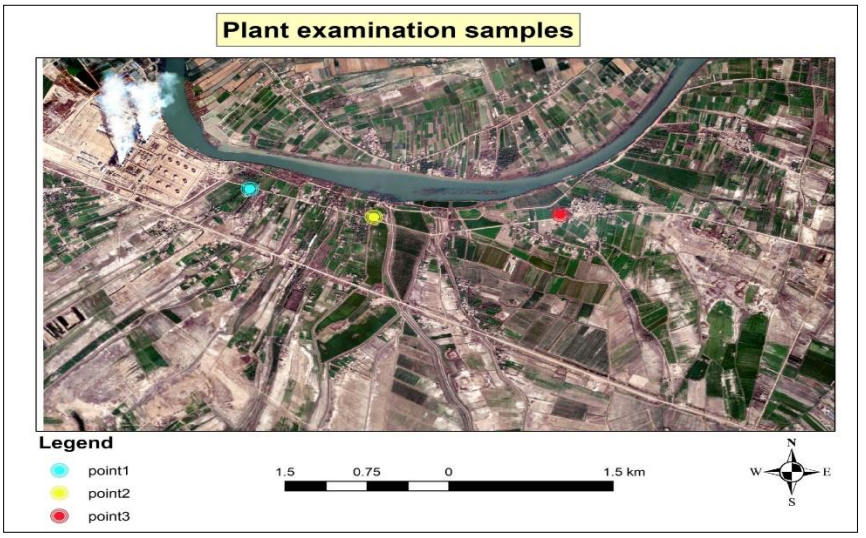

Figure 1.10: Plant test samples site.

On the other hand, the air pollutants and gases released by the station were the most prominent of them (carbon dioxide CO2, carbon monoxide CO, methane gas CH4', nitrogen dioxide, NO2, and sulfur dioxide SO2). There are several gases in addition to sulfates like the mist associated with smoke and the accompanying other chemical elements. This significantly changed the natural atmosphere of the air and agricultural land.

Figure 1.11: State action.

Impact stage

At this stage, all the effects associated with the change of condition that were addressed above include. The change in the level of liquid pollutants that are thrown into the waters of the Tigris River, represented by the continuous polluted hot water, permanently affects the natural and life structure of the Tigris water in the vicinity of the station. The temperature of the water rises up to 10 degrees at the end. This has affected the biodiversity and fisheries, as polluted water hinders the growth and reproduction of fish. Thus, this left its impact on fishing workers within an insignificant space. Especially if we mentioned that the direction of water flow is from the power plant towards the city, and this also causes health problems for the residents.

As for gaseous pollutants and suspended particles, the most prominent of which are sulfur oxides, lead particles and fly ash as a result of burning raw materials with black smoke, which were addressed in the case stage. Table 1.2 shows the effect of increasing each of the elements on the health of the population, and it

has a cumulative risk, especially in the villages near the power plant Which suffers from permanent noise in addition to the above. As for the urban aspect, the urban expansion of the city has declined significantly in the north-west direction. As a result of these effects as well as health diseases and skin rashes that children suffer from, especially in the city Zelizil and its neighborhood, which is inhabited by people that are unable to buy houses legally.

Table 1.2: Gaseous pollutants and suspended particles.

Polluting element	Health effect
Cobalt CO	It affects plants, animals and humans such as heart and causes palpitations
Nickel	It affects the blood circulation and increasing its percentage leads to liver damage
Lead and Cadmium CD	Disruption of the work of the kidneys and lungs, digestive disorders and brain problems.
Sulfur dioxide SO2	Eye, nose and throat irritation, as well as coughing and burns to the skin and eyes
Carbon monoxide CO	Headaches, dizziness, fainting and angina when it exceeds the permissible limits.
Carbon dioxide gas CO2	Harms the eyes, double vision, tinnitus, loss of consciousness and rotation

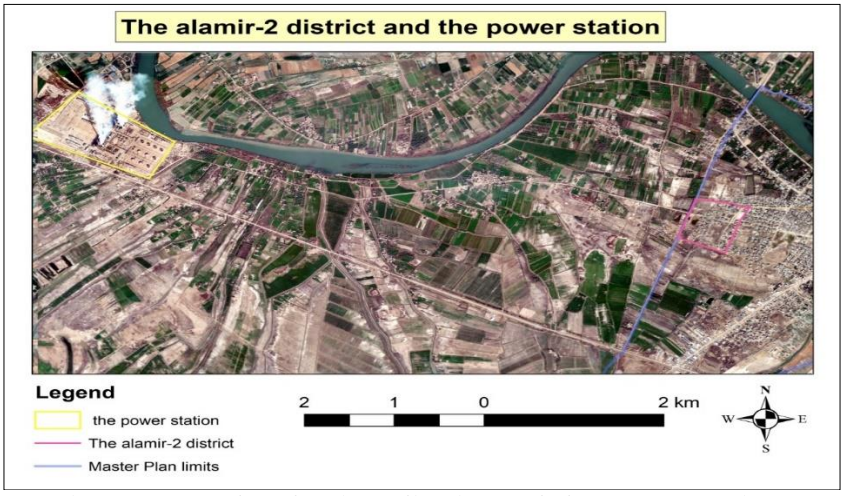

Figure 1.12: The alamir-2 district and the power station.

As for the alamir-2 district, which has slow growth, compared to the rest of the neighborhoods, it was greatly affected by the housing market and the prices. Figure. 1.12 shows these cities and their location.

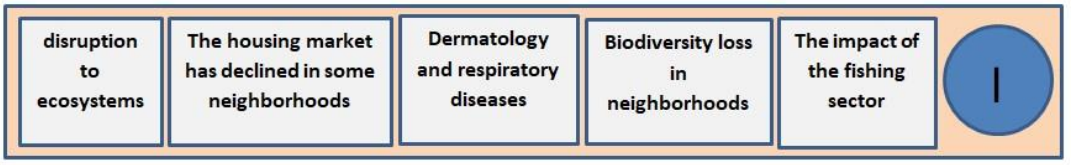

Figure 1.13: Impact action.

Response stage

This stage is represented by the responses that will develop solutions to the problems that were addressed in the case and impact stages. Most of the decisions and treatments were not effective and efficient such as:

1. Using clean fuels represented by gas and reducing dependence on crude oil.
2. Putting filters in the chimneys to purify the air as much as possible.
3. Treatment and purification of the water presented to the river.
4. Recycling waste before burning it to reduce its environmental impact.
5. The use of alternative and sustainable energy represented by solar energy from solar panels and the generation of energy from wind turbine farms and the exploitation of spaces.

Therefore, the DPSIR framework can be applied in analyzing the impact of the electric power production plant as an industrial use affecting the city's environment and its natural resources in the district of Zubaidiya as shown in Figure. 1.15.

Figure 1.14: Response action.

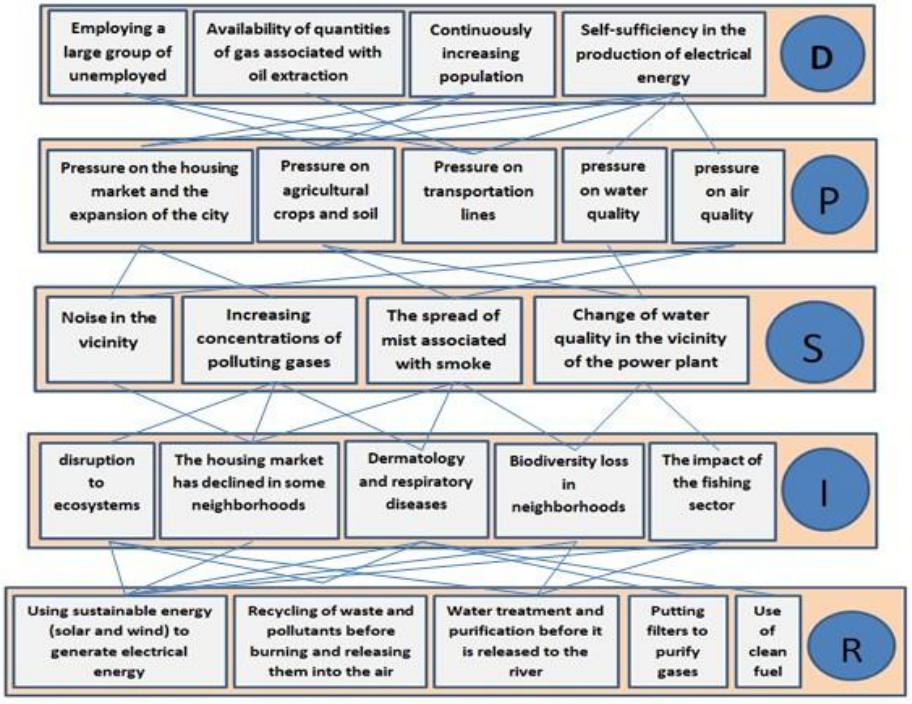

Figure 1.15: Overall DPSIR action framework .

Conclusions and future recommendation

In this study, we explore the main problems related to the electric power production plant in the district of Zubaidiya in Iraq. This study analyzes the main issues, their causes and potential solutions. Images in this research paper are taken directly from the power plant or from other research papers. Overall, the main findings during the study can be summarized as follow:

1. The lack of specialized programs for recording the pollutants resulting from the power production plant in the surrounding areas due to the lack of inspection units and devices.
2. Many heavy elements and polluting gases appeared in ranges that exceed the permissible limits globally at the level of the aquatic environment, air and plants
3. There are elements that have an effect that is not noticeable in the summer examination periods, for example, sulfate acids cleanse their effect in the winter with the help of air humidity, which increases the risk of sulfuric acid resulting from part of this interaction
4. The current responses do not address environmental problems in a sustainable manner, as there are temporary solutions to some problems that delay the occurrence of damage.

Based on this study, we strongly recommend to take the following actions

1. The study recommends increasing the number of devices and stations in Wasit Governorate, which are specialized in measuring pollution levels to work with them on a permanent periodic basis.
2. Paying attention to environmental impact assessment studies for future development projects and activating them within the feasibility studies to take an effective role.
3. Increasing green spaces in the form of a belt surrounding the power plant and using filters for chimneys.
4. Attempting to develop solutions to cool the water before putting it to the river in the form of waterfalls or the like to reduce its impact on the downstream area, as well as treating it with chemicals that reduce the concentrations of toxic substances in it.
5. Providing treatments in the hospital, the most important of which are respiratory and skin diseases, as well as training medical teams specialized in common diseases. [3]

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