Analytical Study of Environmental Impact Assessment for a Wastewater Treatment Plant in Sabratha Libya

Ahmed F. Abugdera, Bashir M. Faris, Mabruk M Abugderha

Abstract— Wastewater treatment plants are considered to be of great importance in their establishment due to the potential danger they pose to the surrounding environment in the absence of technical foundations and capabilities or lack thereof at all stages of design, implementation, operation and maintenance. Environmental impact assessments (EIA) for wastewater treatment plants are conducted to guide the stages of project design, construction, wastewater distribution networks, training of operation and maintenance staffs and future expansions. Not doing it has negative effects that may reach the project penalization as in most wastewater treatment plants in Libya. This study is to assess the environmental impact of Sabratha wastewater treatment plant (SWWTP) to be constructed in Ruwaisa district, 13 km west of the city center. The operational capacity of the plant is 8000 m3/day to serve 32000 inhabitants with a future expansion potential of 16000 m3/day. Law 15 was established in 2003 stipulates EIA prior to the implementation of any project to reduce environmental damages. This study of site field survey, description of the proposed project and potential environmental impacts, identification of the environmental elements likely to be affected by the construction and operation of the plant, assess the environmental impacts, determination procedures to reduce and mitigate the environmental impacts. Three alternatives of produced treated water uses are investigated. The most economically viable alternative was found to be the use of the produced water in green areas irrigation.

Keywords— Environmental Impact Assessment, Proposed Project, SWWTP, Sabratha, Libya.

1 Introduction

Today the treatment of domestic and industrial wastewater is a matter of course in our society. It serves the protection of human health, the preservation of water as an ecosystem, and it also retains the water in a state that makes it usable by humans [1].

Waste discharges from municipal wastewater treatment plants into rivers and streams, lakes, and estuaries and coastal waters are a significant source of water quality problems throughout the country. States report that municipal discharges are the second leading source of water quality impairment in all of the nation's waters. Pollutants associated with municipal discharges include nutrients (which can stimulate growth of algae that deplete dissolved oxygen, a process that harms aquatic ecosystems, since most fish and other aquatic organisms "breathe" oxygen dissolved in the water column), bacteria and other pathogens (which may impair drinking water supplies and recreation uses), and metals and toxic chemicals from industrial and commercial activities and households [2].

Wastewater treatment and reuse is not new, and knowledge has evolved on this subject and has progressed throughout human history. It has reused untreated municipal wastewater for centuries to divert human waste out of urban settlements. The treatment of domestic wastewater is an old and common practice at different stages of development, which has led to an understanding of the best technologies and processes used in water quality treatment [3].

Wastewater treatment plants are developmental projects that need to make more efforts to protect the environment and public health. The reuse of treated wastewater in agriculture or other uses is one of the local strategies that must be reviewed by the responsible authorities in the Libyan state.

It is noted that the environmental changes have emerged and accompanied the scientific, industrial and technological progress. The steady increase in population contributed to the pressure on the natural resources through removing large areas of vegetation to provide housing and replace modern agriculture in place of forests. The use of pesticides and chemical fertilizers resulted in many solid and liquid wastes, which adversely affected groundwater, soil and public health [4].

Wastewater treatment has become one of the most important environmental issues as long as it reduces the pollution of natural water resources. It is known that developed countries have been quick to approach wastewater treatment for more than 100 years, but Libya began to run this experiment in the late sixties. It has until 2017 about 74 WWT Plants. Among which, 10 plants are under operation, 47 are shut off and 17 plants are under construction. The current treated water production does not exceed 30.8 m^3/year and the targeted treated water was 511 m3/year.

It has been confirmed through previous studies that many of the developed projects produce negative impacts on the environment. Environmental impact assessment studies are conducted to predict the negative and positive impacts and determine the necessary procedures to reduce and mitigate the negative impacts and enhance the positive ones.

Environmental Impact Assessment (EIA) is the term used to describe the analysis of environmental cost and benefits that is required by many legislatures prior to granting a license for some new development or extension of a preexisting development that is perceived to have at least some negative environmental consequences. EIA is a short-term, one-off study used by coastal planners to inform sustainable development

and coastal zone management. EIA assesses the likelihood of impacts and their significance and provides recommendations for mitigating the impacts [5].

Environmental Impact Assessment (EIA) is a relatively new planning and decision making tool first enshrined in the United States in the National Environmental Policy Act of 1969. It is a formal study process used to predict the environmental consequences of any development project. It is a technique which is meant to help understand the potential environmental impacts of major development proposals [6].

Environmental Impact Assessment (EIA) is a widespread and legally required procedure used to support local decision-making. According to data collected by the European Commission, approximately 16,000 EIAs are conducted each year across the EU-27 for different types of projects, including infrastructure (i.e., energy, transport, waste, and wastewater treatment) and industrial and urban development [7].

The main objective of the establishment of SWWTP is the protection of the environment and public health. The pollution resulting from sanitation not only harms the environment but also affects the health of individuals. The most taken measures when wastewater treatment plants are established are to minimize the environmental hazards and harmful effects on the employees and surrounding community's health. Determination of the required treatment degree for wastewater is one of the most important elements in the project success. The comparison of the treatment degree and the local standard of the produced water purity is important to identify and evaluate the available alternatives, and to choose the most appropriate one.

2 Materials And Methods

The study conducted a survey and field research, including descriptive analysis, interviews and field visits, gathering the necessary information from the responsible authorities in the region and identifying the most important difficulties in the area surrounding the project. The study investigated the most important difficulties facing the project.

2.1 Location of Study Area

The site is located in the historical town of Sabratha, on the Mediterranean coast, 67 km west of Tripoli, the Libyan capital. The site is located approximately 13 km away from the main wastewater pumping station on longitude (12o34~58.96") and latitude (32o80~04.99"), Figure. 1. It is 5 meters above sea level. The site area is about 25 hectares and the municipality population are 85 thousand inhabitants, of which 20% are connected to a wastewater network. 80% of the population use cesspools. The Sabratha authorities are seeking full connection to the city's wastewater network.

Fig. 1. Study area project.

2.2 Description of the Proposed Project

The required specifications according to the studies and standards required by the responsible authorities in the city for the wastewater treatment plant are as follows:

- Operational capacity of the plant is 8000 m3/day.
- Targeted Population is 32,000 inhabitants.
- Possibility of future expansion of 16000 m3 / day.
- Operating period of erection is 3 years.
- Nature of the land is rocky and flat.
- The site is currently used as dumping various kinds of solid wastes.
- The new ascending line of the pumping station in the city center is paved and next to the railway track.
- The treated water generated from the plant will be used to irrigate the forests, green areas and gardens within the city through a reverse pumping system from the station to the city and the vicinity of the station.

2.3 Statue of the Old Wastewater Treatment Plant in Sabratha (Zuagha)

The existing wastewater treatment plant station was established in 1987, according to the designs and studies conducted by the Greek designer Maggie Marshall in 1974, and implemented by the Austrian company "Stry Bau" in 1976, with the following specifications:

- Operating capacity 6000 m 3 / day.
- Targeted population of this station is 20,000 inhabitants.
- Activated sludge treatment.
- Final treated wastewater use for agricultural purposes and the excess quantity discharged to the sea.
- Use of treated water collection pond to collect untreated wastewater. Dimensions of the basin 120 m × 120 m, surrounded by a soil dam, and the average depth of water (5 m).
- This basin was used as a solution for the collection of untreated wastewater from the city of Sabratha during the station shut down.

The treatment plant stopped working in 1993 due to the siege imposed on the Libyan state at the time, which in turn caused a shortage of spare parts and periodic supplied maintenance. This resulted in the inconvenience of the citizens living next to it due to the accumulation of gray water in the collecting basin, and the spread of insects.

Al-Mahri (2006) made an investigation about the wells near the old waste water treatment plant. He approved the contamination of the groundwater due to the accumulated wastewater in the basin which was used when the treatment plant was shut off [8].

The neighboring citizens were not satisfied with the station's existence in the previous location. The authorities decided to construct a new wastewater treatment plant. The study carried out an environmental impact assessment for the new plant in accordance with Law No. 15 of 2003 with objective to reduce the environmental damage that may result from it.

2.4. Weather and Prevailing Wind Direction

The investigated area has the Mediterranean Sea climate, which is characterized by being dry hot in summer, warm and rainy in winter. The studied area is classified as dry and semi-dry climate, and the climatic manifestations are clear in terms of rain, temperature, wind and relative humidity caused by geographical factors. Figure 2. presents the prevailing trend of wind according to the data of the Meteorological Department. The trend of the wind in the region is not stable. However, the prevailing trend is the north-east, which accounts for 22% of the total prevailing wind in the region [9].

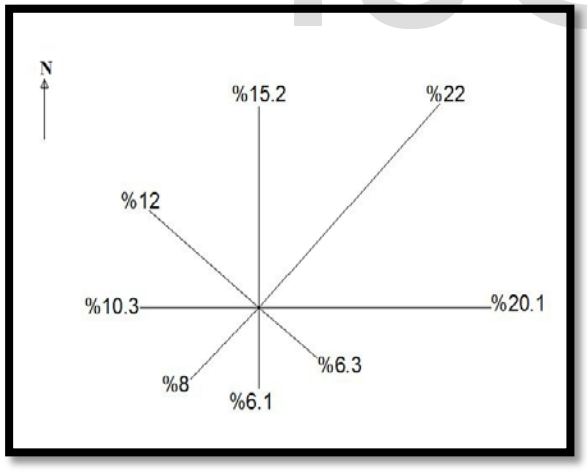

Fig. 2. Wind Direction.

Figure 3. Shows the position of the new water treatment plant location. It can be seen from the figure that the position of the city is located in the direction of wind. The wind can carry out the strong emissions and odors resulting from the accumulated wastewater water. This makes it sensitive in case of the plant shut off because of making residents of these areas around the station vulnerable to some health risks.

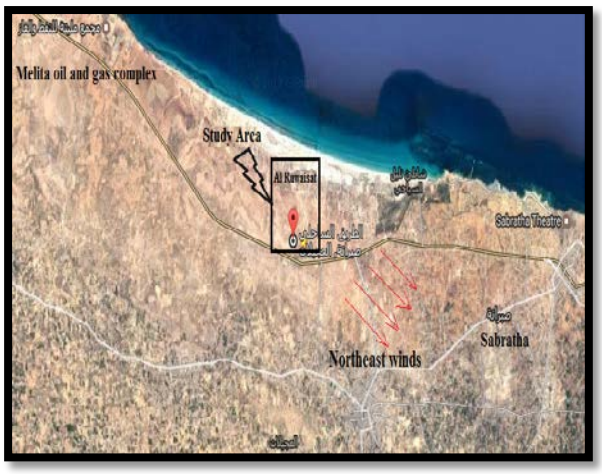

Fig. 3. Prevailing Wind Direction in the Site.

2.5. Site Surrounding Environment

It was revealed through the visits and field survey that there is a project of 5000 housing units under construction Fig. 4 with a distance of about 3.5 km. Figure 5 presents a gas station on the coastal road with a distance of 1.5 km from the plant. The site is adjacent to limestone quarries. The field survey shows the presence of some permanent and temporary grass and trees Fig. 6. Vegetation is valuable in the region's ecosystem and hardly sustainable. Figure 7 shows birds and sheep fed on grass adjacent to the site. The site is currently vacant and has no residents due to its aridity and distance from the city center.

Fig. 4. 5000 Housing Units.

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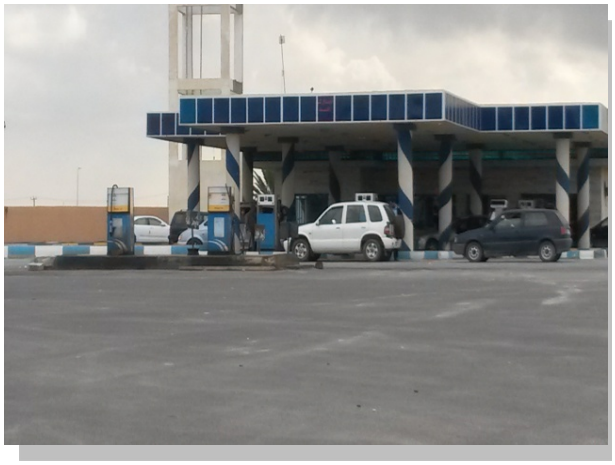

Fig. 5. A Gas Station.

Fig. 6. Flora.

Fig. 7. Fauna.

3 LIBYAN LEGISLATION

The following discussion presents Libyan law as a national regulatory guide relevant to the activities of wastewater treatment plants and is used as a guide for the protection and improvement of the environment. The laws related to environmental impact assessment are summarizing as follows.

3.1. ENVIRONMENT GENERAL AUTHORITY

The main authority responsible for the environment protection in Libya is the Environmental General Authority (EGA), which was established in 1998 by the General People's Committee Decree No. (263) of 2000. It declares that the Environmental General Authority replaces the Technical Center for the Environmental Protection. In 1989, the General People's Committee (Libyan Parliament at that time) issued a Decree No. (386) in the year of 1999 concerning the executive regulations of Law No. (7) in 1982, which included (131) explanatory material of the law. The General Authority for the Environment is an independent body whose responsibilities are exercised in implementation of the provisions of Law No. (15), 2003 related to the protection and improvement of the environment.

3.2. BARCELONA CONVENTION FOR THE PROTECTION OF THE MEDITERRANEAN SEA FROM POLLUTION

Since the beginning of the attention to environmental problems, which have become important over the past years, the Mediterranean countries have taken into account how to save their sea from pollution. After a series of meetings, a plan of action for the protection and development of the Mediterranean region was taken in Barcelona Conference in 1976. The Barcelona Convention for the Protection of the Mediterranean Sea from Pollution was approved by 16 Mediterranean Countries, in addition to the European Market Countries. Libya signed the Convention on 31/1/1977 and rectified it on 31/1/1979. This was followed by the signing of protocols to the Convention in upcoming years. In the area of biological diversity, two protocols have been adopted and signed by the member states [10].

Article 8 of the Barcelona Convention on Pollution from Land-Based Sources provides that Contracting Parties shall take all appropriate measures to prevent the Mediterranean Sea from all types of pollution, discharge of rivers, coastal installations or precipitation, or from any sources within its territory [11].

3.3. LAW NO. (15) REGARDING THE PROTECTION AND IMPROVEMENT OF THE ENVIRONMENT

Law No. (15), 2003 aims to protect and improve human and all living being and their surrounding such as air and soil from pollution. The law specifies the necessary methods to measure pollution and work to protect the environmental balance of the ecosystem and reduce all types of pollutants and damages resulting from them.

Article 7 provides the necessity to conduct an environmental impact study for projects prior to their establishment which

must be approved by the Environmental General Authority. The summary of the articles drafted by the law is as follows:

1. General Provisions (Article 1-9)
2. Protection of Air (Article 10-17)
3. Protection of the sea and marine wealth (Article 18-38)
4. Protection of Water Resources (Article 39-47)
5. Protection of Foodstuff (Article 48-50)
6. Sanitation of the environment (Article 51)
7. Protection against common diseases (Article 52)
8. Protection of soil and vegetation (Article 53-55)
9. Protection of wildlife (Article 56-57)
10. Bio safety (Article 58 -63)
11. Sanctions (Article 64-76)
12. Final Provisions (Article 77-79)

Article 35 of chapter 3 of the law regulations, prohibits the discharge of polluted water to beaches, seas or valleys, including inland waterways or direct flow through drainage pipes, channels, wastewater or land, before monitoring the quality and quantity of contaminants released in a special register prepared for this purpose in accordance with the instructions issued by the commission to determine the quality and methods of collecting and measuring these pollutants. Presentation of the monitoring record of the commission every six months to assess pollution and registration of pollutants and to propose preventive and curative measures and specify appropriate solution levels.

4 Environment Impact Assessment

Environmental Impact Assessment (EIA) can broadly be defined as a Process, providing an anticipatory and preventive mechanism for environmental management and protection to achieve sustainable development. EIA certainly plays a vital role in assessing the environmental impacts of surrounding developmental project. It is a study of the effects of a proposed project, plan or program on the environment. In other words, EIA is an administrative process that identifies the potential environmental effects of any proposal along with its advantages and disadvantages on environment. Positive effects are maximized whereas; adverse effects are minimized to greatest possible extent [12]. Environmental Impact Assessment (EIA) as a process to assess the environmental consequences of any project and design proper mitigation plans to minimize the possible adverse impacts [13].

4.1. Objectives of Environmental Impact Assessment

The objectives of environmental impact assessments of a proposed developmental project are varied from direct objectives and long-term goals. These objectives can be summarized as follows:

1. Protection of the environment and public health.
2. Design projects appropriately to achieve sustainable development.
3. Minimize the negative impacts of new projects on the environment by finding ways and means to reduce and mitigate the negative impacts and promote the positive ones.
4. Achieving a degree of follow-up and monitoring through applicable laws and regulations.
5. Increasing the environmental awareness among the society.
6. Assisting decision-makers in the continuation, modification or suspension of any project.

4.2. Requirements of the Environmental Assessment Process

According to EGA, Environmental Impact Assessment should include the following steps:

1. Executive Summary.
2. General information.
3. Legislation.
4. Description of the proposed project.
5. Description of the surrounding environment and current situation.
6. Description of the environmental impacts of the proposed project.
7. Description of environmental impact assessment.
8. Description of mitigation actions.
9. Description of alternatives.
10. Environmental Management Plan.

5 Result And Discussion

A field study of the site and concerned people interviews were conducted. Besides that, deductive reasoning analysis research was used to predict the negative and positive effects and determine the procedures necessary to reduce and mitigate the negative impact on the environment and enhance the positive one.

5.1. Significant negative environmental impact

Wastewater Plants are generally have small negative impacts. If it is not operated properly or fail to apply the necessary environmental laws and regulations the following effects are expected:

1. Spread of odors and insects due to the accumulation of untreated wastewater water.
2. Vital effects on plants, animals, wild and aquatic life in the area around the project.
3. Some types of ventilation basins in the treatment plants lead to the widespread polluted spray transmitted by the wind.
4. Contain the secondary sludge to a high humidity ratio, leading to a large increase in size and difficult to dry.

5. Lack of awareness of some of the different categories may affect the project in the implementation and operation phases.

5.2. SIGNIFICANT POSITIVE ENVIRONMENTAL IMPACT

1. Reduce the risk of disease transmission resulting from contaminated wastewater and improve water quality in waterways and groundwater.
2. Preserve the marine wealth and reduce the percentage of pollution.
3. Provide a better standard of living by creating jobs during the implementation and operation of the project.
4. The project contributes to strengthening social participation in the management of environmental affairs.
5. Utilization of treated wastewater in irrigating green areas.
6. Achieving the concept of sustainable development and raising the standard of living of the population.

5.3. MEASURES TO MINIMIZE AND MITIGATE THE NEGATIVE EFFECTS

Wastewater treatment plants are considered to be a very important in their establishment due to the potential danger they pose to the surrounding environment in the absence of technical foundations and capabilities or lack thereof at all stages of design, implementation, operation and maintenance. The following recommendations should be observed to mitigate and reduce the negative effects on the environment:

1. Clear emergency preventive measures must approve and all employees have to be aware of it.
2. Development of a clear plan and declared in accordance with the Libyan Labor Law and abide by all the provisions of the general regulations for the protection of the environment and its executive regulations.
3. Develop a monitoring plan to assess the environmental impacts in accordance with local and international standards.
4. The necessity of periodic health examination for the workers in the wastewater treatment plant.
5. Solid waste has to be converted to fertilizer material.
6. Realize an awareness for neighboring citizens to respect the environmental standards.
7. Develop a clear plan for plant operation and commitment with environment.
8. Develop a plan for periodic maintenance and daily laboratory tests to determine the efficiency of the plant.
9. To sensitize citizens and guide them not to put substances in wastewater, which is difficult for the plant to process.
10. Conduct periodical questionnaires and apply statistics to know the positive and negative effects.
11. Undertaking actions to protect the environment and immediately report any irregularities and infringements that cause any pollution or deterioration of the environment.
12. The site must be to settled with natural materials after the project completion.
13. Plant a green fence as an insulating layer between the project and the surrounding environment.
14. The Municipality has to monitor the application of quality standards and continuous improvement.

5.4. ALTERNATIVE ANALYSIS

The use of treated wastewater depends on purity, which is directly related to the cost of construction and operation. It is usually used to irrigate crops, parks, green areas, sports fields, trees, industrial uses such as cooling machines and stone industry. The treated water is used in the industry to reduce the cost of production. It can also be used in recreational purposes, fish farming, laundry latrines, fire extinguishing, construction, Sewerage and re-injection of ground water.

In this regard, the available alternatives for using treated water from SWWTP will be presented according to international, regional and local standards, taking into consideration technical and economic aspects. Table (1) shows an analysis of the three proposed alternatives and their results. The three basic alternatives are:

1. Discharge of treated water to the sea.
2. Injection of water after treatment into groundwater.
3. Use of treated water to irrigate green spaces.

TABLE 1
ALTERNATIVE ANALYSIS

N	Proposed alternatives	Analysis of proposed alternatives	Results
1	Discharge of water after treatment into the Mediterranean Sea.	1. Connecting the drainage pipes within the sea at a distance of 2.8 km as a minimum to reach the open sea according to the Barcelona Convention [14].	1. Need specialized companies. 2. Need periodic maintenance. 3. Economically expensive.
2	Water injection after treatment into groundwater.	1. Given the absence of Libyan specifications describing the quality of water to be injected into groundwater. 2. The possibility of using international specifications for the injection of groundwater.	1. Need advanced processing. 2. High economic cost. 3. Accurate control of the product.
3	Use of treated wastewater to irrigate green areas.	1. Local standards and standards determine the quality of treated water for agriculture [15]. 2. In this case you need triple treatment.	1. Preservation of groundwater. 2. Utilization of treated water in the irrigation of green spaces. 3. Lower cost compared with other alternatives.

We note from the analysis presented in the table that the most appropriate alternative is to use the treated water to irrigate the green areas due to its relatively low cost and its role in conserving the groundwater and enhancing the advantage of mitigation and reduction of visual pollution in the project area

6 CONCLUSION AND RECOMMENDATION

Most of the stations have stopped due to the absence of an environmental impact assessment procedure assist the design works, construction of the stations, wastewater distribution networks, operation and maintenance staff training, and future expansions. These variables are important elements in conducting environmental impact assessments before the establishment of any wastewater treatment plant. Therefore, we recommend conducting an environmental impact assessment for existing and new wastewater treatment plants.

The study concluded that the negative environmental and social impacts resulting from the proposed project during the construction or operation phase are limited and can be mitigated by taking the appropriate measures. The other is done through a monitoring team according to the stages of the project implementation, commissioning and operation.

The daily consumption of 250 liters/person/day used in station design is contrary to the national standards, which set the consumption of 200 liters/person/day with the need to emphasize the existence of sufficient water to meet the requirements of the residents.

The station is located in the mainstream of wind movement, which in turn will cause the transfer of odors to the city. The study recommends to find an adequate source for the station and redesign it according to the specific rate of absorption in the city and selecting another site away from the direction of the prevailing wind.

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