

Impact of Oil and Gas Exploration on Marine Environment and Activities in Red Sea

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1. ABSTRACT: Development in Oil and Gas industry in Egypt went a step forward recently, and in order to have a new oilfield, the exploration operation is a must. The author focused on different types of seismic survey as the latest technology used in the Oil and Gas exploration, which has been specified with evidence for the newly confirmed agreements between the Egyptian government and the international exploration companies targeted the Red Sea as a fresh exploration area.

Furthermore, the environmental impact from the sound energy used in the seismic survey has been explained and the types of marine mammals living in the Red Sea affected has been identified among other creatures. Mitigation measures towards protecting our marine mammals has been proposed. Moreover, the seismic survey vessel with her extended gear would affect many marine activities such as vessel's traffic and fishing boats in the area of operation.

The author studied the routes might be affected by the seismic operation for the

Easterly seismic blocks in the red sea and proposed procedures to avoid any risk with the steaming vessels in this area and proposing also some solutions to avoid any harm could occur to the fishing activities. Finally, the author concluded that the Environmental law in Egypt should have an article to identify specially the impact of the seismic operation on marine environment and to include brief description for the procedures which should be followed to avoid any consequences might arise.

Keywords: *Seismic Survey, Acoustic Energy, Marine Mammals, Mitigation Measures, Vessel's Traffic, Fisheries, Egyptian Law.*

2. INTRODUCTION

The industry for the Oil and Gas offshore is considered as an important factor in the blue economy. It had many processes in place before achieving the final product. It started with the exploration which led to drilling in order to have a reservoir and finally the product should be either exported as a raw or enter the refining process before exporting or used locally. Each process stated above had an impact on the marine environment and the different marine activities within the affected operational areas.

In this research paper the author is intended to focus on the Seismic Survey as a mean of exploration and is aiming to find its impact on the marine environment and the different marine activities in the red sea in Egypt.

The importance of this paper is to advise the authorities to have some extra measures to ensure the safety of navigation in the red sea in line with the seismic survey operation in this area in addition

to the care about the environment and the fisheries activities in the red sea.

The paper consists of different sections, first it identified the exploration area in the red sea in Egypt, followed by an explanation for the seismic survey, then the author identified the environmental impact with procedures and vessels traffic and fisheries activities followed by the suggested measures to reduce the impacts from the seismic activities.

3. EXPLORING AREAS

Governments should assign the exploring areas in their offshore waters as blocks with agreed dimensions. Blocks should be opened for a tender to the oil and gas companies. The bid should be awarded to the best proposing company and the award should be mainly related to the accepted percentage of share for the expected product from the reservoir in-between the contracted government and the awarded oil and gas company.

In the red sea in Egypt, the government of Egypt for instance identified in 2018 ten new blocks with an area of 30,000 square Kilometers and the government was planning to make a Two- Dimensional (2 D) survey for all of them before releasing them for a tender in order to have as an initial data to help the oil and gas companies to identify the target of their production, Figure 1 identifies the ten blocks in the red sea (Schlumberger, 2019).

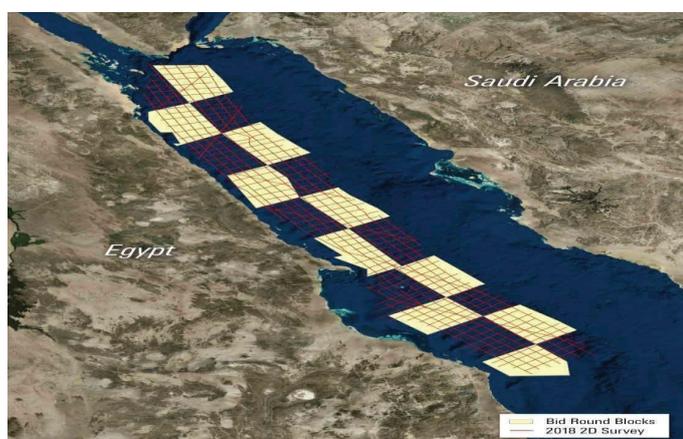


Figure 1 : Blocks in The Red Sea
Source:(Schlumberger, 2019)

4. SEISMIC SURVEY

Marine seismic survey uses the acoustic energy to understand the seabed from its geological point of view. Seismic survey vessels use air guns to produce pulses of high-energy which penetrates the seabed and then the echo should be reflected back to the surface of the water where the hydrophones receive the echoes and by using the reflected data, the geological maps below the seabed should be developed (CAPP, 2016).

4.1 Types of Seismic Survey

There are different types of marine seismic surveys including;

- **Two Dimensional 2-D Surveys**

Uses one source of the acoustic energy in addition to one receiver.

- **Three Dimensional (3-D) Surveys**

Air guns are used as transmitters and hydrophones are used as receivers in order to have a more detailed picture for the geological nature of the sea bed.

- **Four Dimensional (4-D) Surveys**

It is the multiplication of the 3-D survey with a comparison between the geological changes happened in a certain area over a certain period of time and the time in the 4-D is considered as the fourth dimension (CAPP, 2016).

5. ENVIRONMENTAL IMPACT

The speed of the sound under the water surface moves five times faster than its movement in the atmosphere and this movement is accompanied by a great coverage (Sabine ,2019). As a result, sound is used by many marine organisms to communicate, navigate and find food (Compton et al, 2008). Consequently, the presence of the seismic survey activity with the existence of the powerful air guns should definitely had an impact on the marine creatures. (Russell, 2018). And in particular; the marine mammals (Abdulla & Linden, 2018).

Unfortunately, the seismic surveys might extend for months in a certain area (Abdulla & Linden, 2018). Specially, if the survey area consisted of many blocks and they are close to each other's same as the case for

the ten blocks in the red sea of Egypt. For Instance, The Company PXGEO should be involved for a 3 D project in the Egyptian Red Sea for a period of four month starting from November 2021 (Energy Egypt, 2019). In Addition, The Company TGS announced on 29th of October 2021 the awarding of a 3D project in the red sea for an area of 6800 square Kilometers (TGS, 2021).

As shown in figure 2 below gives an example for a seismic survey vessel operating with a length of a spread with a 12 km length and with a 700 m breadth.

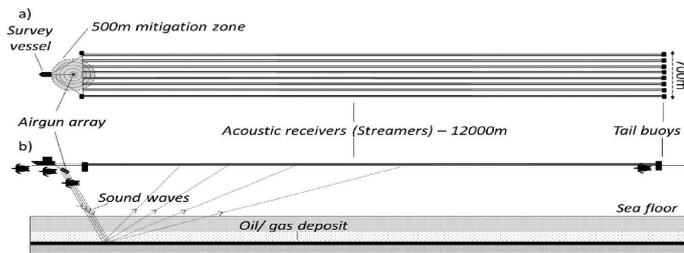


Figure 2: Seismic Survey Spread
Source: (ARS, 2021)

The biggest seismic spread for a seismic vessel was recorded in the world is the spread towed by the seismic survey vessel Ramform Hyperion with 18 streamers towed and each one was with a length of 8025 meters with an achieved a world record for 144.45 km streamers towed behind a vessel (Habibic, 2021).

6. TYPES OF MARINE MAMMALS MIGHT BE AFFECTED BY THE SEISMIC SURVEY IN THE RED SEA

Table 1 identifies the type of species in the red sea that could be affected by the acoustic energy of the seismic survey.

Table 1. Marine Mammals in The Red Sea

Species	In English	Occurrence	Notes
Balaenoptera Edeni	Bryde's Whale	possibly regular	
Megaptera novaeangliae	Hump Back Whale	rare	
Orcinusorca	Killer Whale	rare Records	limitedto the southern Red Sea
Pseudorca crassidens	False Killer Whale	regular	
Globicephala macrorhynchus	Short Finned Pilot Whale	rare	
Grampusgriseus	Risso's Dolphins	regular	
Tursiops aduncus	India Pacific Bottlenose Dolphins	regular	
Tursiops truncatus	Common Bottlenose Dolphins	regular	
Sousaplumbea	Indian Pacific Humpback Dolphins	regular	
Delphinus capensis tropicalis	Indian Ocean common dolphin	possibly regular	Records Limited to the southern red sea
Stenella attenuata	Pantropical Spotted Dolphin	regular	

Source: (Giuseppe et al, 2014)
http://apc.aast.edu

As shown in Table 1, the red sea had a number of 13 species who are marine mammals and could be affected by seismic survey noise.

Furthermore, the turtles should be also considered about as a spicy which might be affected by the noise from the seismic survey and should be included in the mitigation measures in order to avoid consequences from the seismic surveys (Nelms et al, 2016).

7. SEISMIC SURVEY CONSTRAINTS

The number of the countries allowed the exploration for the Oil and Gas in their economical water are 50 countries including Egypt (Nelms et al, 2016).

Soft Start means the gradual increase in emitted sound levels from an air gun array by systematically turning on the full complement of an array's air guns over a period of time. In addition, the objective of the soft start is to get the mammals alerted from the seismic operation in order to have an enough period of time for them to evacuate the immediate vicinity before the initiation of the seismic operation. (Rodi & Herbst, 2012). In addition, Marine Mammal Observer (MMO) is required to be presented during some phases such as; pre-start and soft start, or when the source is active (Department of Conservation, 2016).

Furthermore, the marine mammal's observations should take place from the highest platform on board the vessel by a trained mammal observer during the pre-watch and the soft start periods; and preferably during all daylight hours and in case any species has been spotted, it should be reported in a complete and accurate report in an acceptable time frame (GHFS, 2015).

Finally, there are 500 m exclusive zone and no mammal should go inside this exclusive zoon during the operation of the air guns which could be monitored and tracked only via visual observations and the soft start should be initiated using the smallest gun and the seismic crew should then increase the number of the air guns gradually in a period between 20 minutes and not more than 40 minutes and if a marine mammal entered the exclusive zone. Then, the seismic vessel had two options, either to get all the guns to stop immediately. and the vessel needs after that a 30-minute mammals watch which should be done by a qualified marine mammals observer

for the seismic area before the soft-start being triggered again or by maintaining a minimum source level and the vessel will not be required in this case to conduct the 30-minute visual clearance for the exclusion zone before ramping back up to full output but to achieve that the seismic vessel are required to do some activities such as; maintaining the minimum source levels during the turns before the start of the new shooting line (Rodi & Herbst, 2012).

According to the Egyptian Law number 4 for the year 1994 and its amendments for the year 2009. The oil exploration was stated in different locations within the law as in Article 1 item number 36 for the explanation of the meaning of the exploration facilities according to the Egyptian Law. Article number 39 focused on the prevention of pollution by resultant waste or debris from the exploration organizations into the air. Article number 41 focused on getting all the exploration organization to observe all legal requirements according to national and international authorities. Article number 52 preventing any national and foreign company involved in the exploration to discharge any pollutant into the territorial or economical water of Egypt and not to hurt the water environment and to follow the international conventions regarding any discharged waste and nothing was stated regarding the noise pollution and its effect towards the water species withing the Egyptian economical sector. Article 54 focused on accidental leakage from exploration and the immediate measures needed for control. Article 67 stated the exploration vessels focused on controlling the disposal of garbage. Article 96 focused on the ship's master responsibilities and liabilities for any harm and for payment of fines and expense required to correct the effect the pollution occurred.

8. MARINE ACTIVITIES AFFECTED BY THE SEISMIC SURVEY

The marine activities in the red sea which could be affected by the seismic survey operation could be the steaming vessel's traffic within the covered areas and the fisheries activities.

In the following section the author identified the risks associated with vessel's traffic and fisheries in the red sea.

8.1 Vessel's traffic in the Red Sea:

According to publication number 72 (Sailing Direction Enroute Red Sea and Persian Gulf) as shown in figure 3, it represents section 3 (The Red Sea Central passage with the traffic related to that area). In addition, figure 4 shows the red sea ship traffic for instance on 15th of November 2021. This is considered as a prove that the vessel's traffic might interfere with the locations for the Egyptian exploration blocks and specially the Easterly located 5 Blocks as identified in figure 3.

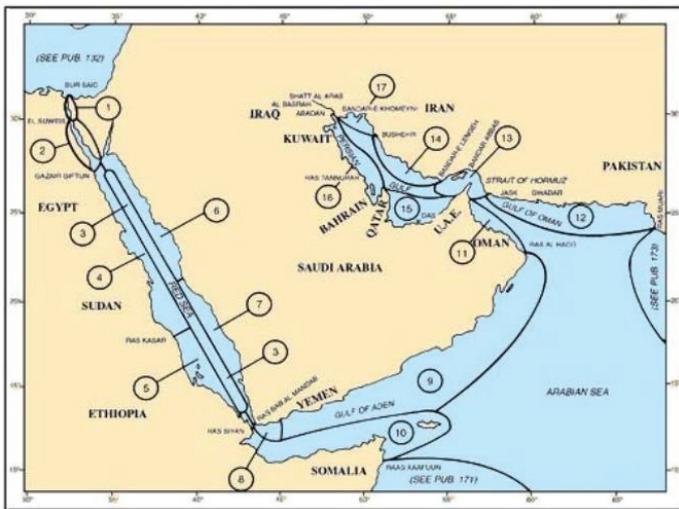


Figure 3: Routes in The Red Sea
Source: (NGIA, 2020)



Figure 4: Vessel's Traffic in The Red Sea
Source: (Ship Traffic, 2021)

8.1.2 Seismic Survey Hazards Towards the Vessel's Traffic

The Probability of having some major hazards affecting the steaming vessels passing by the survey area such as the damage to the rudder or the propeller if they have been hit by the seismic gears or if the streamers has been tangled over the propeller. Additionally, we should not ignore the damage which could happen for the seismic gear itself and this gear is considered as high value asset for the seismic survey companies. Furthermore, collision and grounding might also occur because of the long-towed gear from a seismic survey

vessel which is considered as a vessel restricted in her ability to maneuver requesting from all the steaming vessels making way through the water to alter their courses or reducing their speeds which is common and significant to marine seismic survey operations (Asuelimen, et al, 2020).

8.1.2.1 Procedures to Avoid Collision with other Vessels

In order to avoid the risk of collision for the seismic survey vessel or the seismic gears with other vessel there are some procedures should be in place (Tetra Tech, 2017).

- "Notice to Mariners" to be issued and to start broadcasting before the start of the seismic activity with enough time including the coordinates of the vessel activity.
- Traffic to be warned using the chase vessels and the support vessels.
- To have appropriate lighting and signaling means on the seismic vessel including the towed gear limits and the chase vessel to prevent the collision hazard with either the fishing vessels or cargo vessels.
- All vessels engaged in the operation should be equipped with all equipment required for the safe operation such as; radar, navigation equipment, and communication equipment to identify obstructions and to provide sufficient warning of approaching surface vessels that might cause a danger to the operations.
- The survey should be stopped in poor visibility or extreme weather conditions.
- Upon completion of the survey demobilization of the gears should be achieved as soon as possible and cancellation of the initial "Notice to Mariners" should be effective.

8.2 Fisheries of the Red Sea

Noise from the acoustic energy fired by the air guns had the possibility to make rapid changes in pressure which might cause a damage to the tissues and the organs in fish which is known as the barotrauma (Carlson, 2012).

Methods of fishing in the Red Sea are using approximately 1250 vessels in-between; (Long line, hand line, trammel nets and gill nets) and we could add to them some unregistered fishing vessels in addition to trawlers but trawlers are active only in the Gulf of Suez and the foul bay with a fleet consists of 71 trawlers and 43 purse

seiners engaging in a fishing trip in between 20 and 30 days if they aimed to work abroad. Recently, twenty registered long liners in Hurghada are currently operated as trawlers and purse seiners, they are about 20 m in length and powered by 200 to 220 hp as shown in figure 5.



Figure 5: Purse seiners in Hurghada
Source: (123RF, 2022)

Figure 6, indicates the annual catch in the Red Sea by fisheries from 1995 till 2016 and counted in thousand tons.

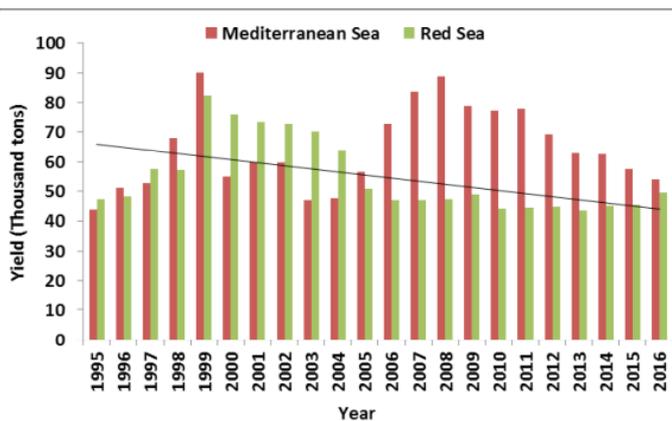


Fig 6: Annual Catch of The Mediterranean and Red Sea Fisheries
Source: (Maiya et al, 2020)

8.2.1 Procedures for the protection of the fisheries activities in the Red Sea

Many mitigation measures should be in place to avoid the harm that might affect the fisheries activities as below (Tetra Tech, 2017)

- (1) At least one month before the survey a "Notice to Mariner" should be issued regarding project activities to all affected parties.
- (2) Fliers with introduction about seismic survey equipment and coordinates for the operation area should be distributed in the fishermen groups and associations.
- (3) Meeting with the fishermen could be beneficial

prior to the operation.

- (4) Patrols should be initiated one week before the start of the seismic survey activity, and all obstructions should be removed in the survey area. All the location and information of removed fishing gear.
- (5) Fishing vessels operating or passing by should be warned using the chase boats.
- (6) Chase vessel with representative from the fishing communities should be employed to ensure navigational safety and appropriate management of fishing interactions.
- (7) Upon completion of the survey, all equipment should be removed from the project area,
- (8) Organize a complaint, problem, and suggestion receiving point for the entire project duration. Findings from complaints and suggestions shall be reported to fishermen associations.
- (9) local fishing vessels should be hired and employed as chase vessel during the survey period to work inside the survey area.

9. CONCLUSION.

Seismic survey is a very important activity for the Oil and Gas industry but it has many consequences due to its effect on the steaming vessels passing by the Egyptian economical waters in the red sea and the fishing activities in the operational areas. In addition, the environmental impact from the use of the acoustic energy in the water on the marine mammals among other creatures.

On the other hand, the Egyptian environmental law including all its articles did not have a special procedure to deal with the seismic survey implications.

Therefore, this paper recommending procedures to be followed during the seismic operation related to the vessel's traffic control and fisheries activities. In addition, a recommendation to make some changes in the articles of the Egyptian Environmental law to cover the mitigation measures against the consequences of the seismic activities towards the marine mammals, fisheries and turtles.

The importance of the this paper is to achieve the exploration of the oil and gas in the Egypt but with the achievement of sustainability from the environmental

point of view and economical point of view by saving the environment and issue regulations to protect the Egyptian economy related to shipping and fishing activities by following procedures already has been used in different places around the world to achieve the same target and to have a parallel track to benefice from the mine property of each country but without causing any lose in any related activity could be negatively affected from the oil and gas exploration.

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