Coral Reefs Damage Assessment Due to Oil Pollution in Egyptian Water

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Abstract. Coral reefs are the most biological systems productive and versatile on the surface of the planet earth, which is a source with economic and social, returns great for the country that God-given this natural wealth. Egypt is home to some of the most spectacular coral reefs and associated marine life in the world. Egypt has enacted laws and takes effective measures for the protection and management of coral reefs and associated ecosystems in the Red Sea and its Gulf to characterize these areas of the richness and diversity of coral reef environment is scarce to be repeated elsewhere in the world. The largest sub-sector for the Egyptian tourism market is the coastal tourism. Coastal tourism depends largely on intact reefs, and this is also one of the most important causes of reef degradation in Egypt. Over the last two decades live coral cover has declined in Egypt. Egyptian Environmental Affairs Agency (EEAA) implements its own methodology to estimate the coral reefs impacts as a result of the destruction of coral reefs due to ship aground or anchorage. This paper focuses on and presents the modelling of the destruction of coral reefs as a result of the collision and the ship ground damage assessment in case of oil spills in Egyptian coastal water referring to the EEAA methodology applied in Egypt.

Introduction

The Red Sea is part of a major world shipping route which currently carries around 7 percent of the global seaborne trade. Much of the world's crude and refined oil cargoes pass through the Red Sea and Gulf of Aden. About 20,000 ships pass through the Strait of Bab al-Mandab each year and an estimated 25,000 to 30,000 ships transit the Red Sea annually. Apart from ship-related pollution risks (e.g. discharges of garbage and oily wastes; bunkering activities), accidents involving tankers together with discharges from unloading operations constitute a serious pollution risk [1]. Coral reefs in the Egyptian Red Sea region are among the most spectacular in the world, it is the main attraction of tourism in Egypt. Its implication on tourism and national income may be severe [4]. Coral reefs are important because they bring in billions of dollars to our economy through tourism, protect coastal homes from storms, provide promising medical treatments, and provide a home for millions of aquatic species [10].

Coral reefs are among the most biologically diverse ecosystems. They are important producers of nutrients and thus play a significant role for many marine species. While coral reefs have adapted to numerous natural impacts over thousands of years, the human impact is actually a greater threat, against which such a vulnerable ecosystem can hardly compensate [2]. These reefs contribute a variety of valuable benefits to local communities and to the gross national product of countries in whose waters they lie. These benefits include commercial, artisanal and ornamental fisheries; bio-prospecting for new pharmaceuticals; mining; revenue from tourists keen to observe their natural beauty; and shoreline protection [13]. Many areas along the Egyptian coasts are at risk from natural impacts created by geological and meteorological disturbances of sea surface and man-made impacts due to human interventions to the coasts. These risks are of two kinds (a) short term risks associated with storms, swells, reclamation pollution, etc., and (b) long-term risks related to climate change, sea level rise, damming of the river, coastal protection measures, etc [8]. In this paper, author's present only oil

pollution impacts on coral reefs. It is estimated that 20% of the world's coral reefs have been effectively destroyed, 24% are under immediate risk of collapse, and a further 26% are under a longer term threat of collapse [17].

Coral reefs types in Egypt are indeed a major marine ecosystem because those species diversity greatly exceeds that of any other marine environment. They are generally known as the rainforest of the oceans. It is assumed that, while their total area is less than 0.2% of the sea surface, coral reefs host almost 30% of all the marine biodiversity, Living animals, mainly coral colonies, produce coral reefs [9, 15]. Coral reefs are structures built on a hard surface and found in oceans, seas and lagoons. The main types of coral reef structures in Egypt are fringing reef, barrier reef, atoll, patch reef, and Bank or Platform Reef. Different Kinds of Coral reefs come in a variety of shapes, sizes and colour. But in general there are two types of corals: Soft Corals and Hard Corals. Soft Corals; called soft corals because they do not have hard, rigid permanent skeletons, this group is made up of the Gorgonians and the Black Corals. Hard Corals; this group is made up of the hydrocorals and the stony corals. Both types of coral have hard skeletons made of calcium carbonate [11].

In 1987 the management of the protected area of Ras Mohamed issued a report about the increase in the number of ships grounding in the Egyptian Red Sea Region. As a result of this report, the Egyptian Environmental Affairs Agency started to deal with ship grounding accidents as a threat to the marine environment. The officially recorded numbers of ship/boat groundings, from 1987 and up till July 2008 in the Egyptian Red Sea Region in the neighborhoods of the most famous major resort cities as dhahab, hurghada, nuweiba, marsa alam, ras sidr, safaga and sharm el-shikh, is 149 incidents [8,13].

Severe damage to corals may result in a collapse of the complex community of organisms, which live in close association with the corals. Concern for damaging effects of oil pollution on coral-reef communities is currently growing due to the big loss in national income from tourist [7]. The global importance of petroleum and the resulting maritime traffic poses a serious threat to the fragile coastal and marine environments of the semi-enclosed waters of the Region. Routine operational leaks and spills from the production and transport of oil constitute the major source of marine pollution. The main source of marine pollution in the Region is from ship-based sources, in which millions of tonnes per annum pass through the region, oil exploitation and offshore oil production. While production and transport of oil continue to play a critical role in the Region's economy, they also constitute major sources of marine pollution. The marine pollution could be derived through the discharge of oily ballast water and tank washings by vessels, operational spills from vessels loading or unloading at port, accidental spills from grounded vessels, collision of ships, and leaks from vessels in transit [14,16]. In a major incident the short-term environmental impact can be severe, causing serious distress to ecosystems, coral reefs and to the people living near the contaminated coastline, affecting their livelihoods and impairing their quality of life [6]. Coral reefs are highly productive areas which support a diverse group of organisms, including many commercial fish species. In Egypt they are often associated with commercially important dive sites. Coral reefs are easily damaged if oiled, may take several decades to recover if killed, and are difficult or impossible to clean. The susceptibility of coral reefs to oil damage depends on a number of factors: e.g. size of spill, type of oil, type and depth of coral reef, the local wave energy, the current stress of the corals, etc. In many cases oil slicks will float over reefs without causing damage to the submerged corals and associated organisms. Biological productivity per square meter of coral reef is usually 50 to 100 times more than in the surrounding oceanic waters. On a local scale, reef areas are an important fishery resource, are a barrier to coastal erosion, and their amenity value is often the basis of tourism development. Serious damage to corals can result from oil pollution. Coral reefs are considered most sensitive to oiling [12].

Methodology for Coral Reefs Damage Assessment in Case of Oil Spills in the Egyptian Water

The Law No. 4 of January 1994 is basic law for the Protection of the Environment in Egypt. The European Union financed a project for the development of protected areas in the Egyptian Red Sea region. The project management found the opportunity to form a special task force to solve the

problem of valuation of the coral reefs using scientific methods. As a result a methodology to evaluate the damage of coral reefs due to ships' accidents in moneywise. The procedure was presented at the International Coral Reef Symposium in 1996. The methodology was also recognized by law courts, insurance companies, and ship owners' clubs and the Egyptian legal system was able to claim millions of dollars in compensation for reef damage. According to this procedure the compensation charge can be estamited using the following formula as in (Eq. 1) [3, 5].

$$\text{Compensation Charge} = A \times LC \times D \times RP \times V \quad (1)$$

Where; A: is a measure of area or impacted area in square meters (m^2), LC: is the percentage of living coral, D: is the percentage damage in the area, RP: is the number of years required for recovery and, V: is the value of one square meter of the reef (V: set at US $120 in 1992 but now increased to US $300 for national parks) [13].

Integrated Oil Spill Damage Assessment Model (OSDAM)

This paper focuses on and presents the Modeling of the coral reefs damage assessment in case of oil spills in the Egyptian coastal water which is a part of a major integrated research program of title OIL SPILL DAMAGE ASSESSMENT MODEL (OSDAM) for simulating of spill trajectory, Environmental Damage (i.e. Coral Reefs & Shoreline) and Economical Damage assessment. OSDAM is designed as an oil spill support tool for emergency responder and contingency planners to estimate whether the economical and environmental impacts as a result of oil spill in coastal water of Egyptian. Using Geographic Information System (GIS), the authors' implement an integrated automated system between the OSDAM and Oil Spill Trajectory Model to assess the damage of the impacted type of coral reefs directly. The detaials of such program will be published soon.

Assumptions & Implementation for Simulated Scenarios

It is extremely important that an assessment be conducted as soon as possible after the incident so that damage to biota and the substrate can be easily identified, measured and documented with still and video cameras. Responders and planners feed the OSDAM model with the appropriate input data of the incident to run the program which are type of coral reef, the impacted area of coral reefs in square meters, the percentage of living coral, the percentage damaged in the area of coral reefs, number years required to recovery the coral reefs and value of one square meter of coral reefs. Two assumed scenarios of coral reef impacts by oil spill assess (Table 1) were investigated by the OSDAM program.

Table 1: Assumed input data for the two scenarios of coral reefs impact and results from OSDAM

Inputs Coral reefs type	**Scenario 1** Fringing reef	**Scenario 2** Fringing reef
A: Impacted area in m^2	1000	1000
LC: % of living coral	45 %	45 %
D: % damaged of the area	100 %	60 %
RP: Number of years required for coral reefs recovery	25	15
V: Value of one square meter (1 m^2) of the reef	300 $	300 $
Results From OSDAM: Total damaged assessment in coral reefs in American Dollars	3,375,000 $	1,215,000 $

Conclusion

The important coastal and marine environments and resources of the Egyptian Red Sea is subject to a series of individual and cumulative threats which have significant short-term or long-term consequences for sustainable development in the Egyptian part of Red Sea region. Coral reefs are recognized as important ecosystems, contributing significantly to livelihoods and income in many countries. The advent of laws demanding compensation for damage to coral reef and the amount paid in fines has been shown to have a positive effect on the number of accidents recorded; they have gone down. This paper focuses on and presents threats to coral reef environments in Egypt and a proposed program OIL SPILL DAMAGE ASSESSMENT MODEL (OSDAM) which facilitates the damage assessment of coral reefs and help the planners and assessors for estimating coral reefs damage in case of oil spills in the Egyptian coastal water.

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