

Effect of Oil Spills on Marine life

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Abstract

Oil spill is the release of a liquid petroleum hydrocarbon into the environment, especially marine areas due to human activities and is a form of pollution. Oil spill pollution can have multiple causes both of natural and anthropogenic origin. The major oil spills of the world include Exxon Valdez oil spill, Arabian Gulf spill, Deepwater Horizon spill and Mumbai oil spill. Oil spills have negative impact on marine ecosystem which includes both plant and animal life. Even the salt tolerant species of mangroves are being affected as the roots become clogged which results in oxygen cut off. The animals which are most effected include Pinnipeds, Sirenians, Cetaceans, Marine mammals, Sea birds, Sea turtles etc. Oil spills can be controlled by both natural and synthetic methods. Usually most of the oil spill accidents are caused by human errors. Hence, this can be reduced if one takes required precautions and proper safety assessments.

Keywords: Oil spill, pollution, hydrocarbon, marine ecosystem, anthropogenic, mangroves, clogged

INTRODUCTION

Oil Spills Sad but True

Liquid petroleum hydrocarbon which is released in to the environment, especially marine areas due to human activities is referred to as 'oil spill' and is a major form of pollution. It also refers to marine oil spills where oil is released into ocean or coastal waters. The main sources of release of crude oil and its products occur when the transport by oil tankers occurs as well as when there is loading and unloading of oil [1]. These undergo number of biological and chemical processes in the marine environment. Evaporation, spreading, emulsification, dissolution, sea-air exchange and sedimentation are the physical and chemical processes whereas many elements of petroleum undergo chemical oxidation in the presence of sunlight, as a result of which a wide no. of degraded products such as floating tar lumps, dissolved and particulate hydrocarbons are deposited in the sea bed.

CAUSES OF OIL SPILL

The main courses of oil spills are both natural as well as anthropogenic. The main anthropogenic sources include [2]:

1. Accidental Spills

Oil and oil products can be stored in both above as well as underground storage tanks, they may undergo leakage with passage of time.

2. Handling

During transfer operations and various uses:
Transport:

- Big oil spills on water or land through accidental rupture of big transporting vessels.
- Smaller oil spills through pipelines and other devices and their impact are mainly due to a large number of usual minor spills.

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3. Offshore Drilling

It is a mechanical process where a well bore is drilled below the seabed. Offshore presents environmental challenges both from produced hydrocarbons and the materials used during drilling operations [3].

4. Release of oil may also occur whenever ships are cleaned for maintenance purpose

At the shipyards while overhauling, the unintentional or negligent release of used gasoline solvents and crankcase lubricants by workshops greatly aggravates the overall oil spillage problem.

5. Road Run Off

With many precipitation events, the original small amounts of oil from regular traffic would get move around and may build up in our environment.

6. Intentional Oil Discharges

The deliberate discharges from oil tankers have been the biggest source of oil pollution from ships which is greater than much accidental spills.

7. Indirectly through Burning of Fuels, Including Vehicle Emissions

Burning would release various individual components of oil and oil products such as variety of hydrocarbons (out of which benzene and polycyclic aromatic hydrocarbons are very dangerous).

MAJOR OIL SPILLS

Major oil spills have been shown in Figures 1–4.



Figure 1. Exxon Valdez oil spill (1989) [4, 5].
Location: Alaskan water.
Quantity of Oil Spilled: 260,000 barrels.



Figure 2. Arabian Gulf Spill (1991) [6].
Location: Persia Gulf.
Quantity of oil spilled: 6–8 million barrels.



Figure 3. Deep-water horizon oil Spill [7].
Location: Gulf of Mexico.
Quantity of Oil Spilled: 4.9 million barrels



Figure 4. Mumbai oil Spills [8].
Location: Mumbai.
Quantity of Oil Spilled: 2900 barrels

EFFECT OF OIL SPILLS

Local Industries

In case of local industries it includes tourism such as fishing, swimming or sailing which is made impossible due to an oil spill. Fishing industry suffers majorly, not only because of the loss of large

amount of marine life but also the catch obtained would be covered in oil and is hence inedible as it becomes poisonous.

Human Health

Human health is also badly affected. Health can be harmed by any of the ways like: Inhalation of oil vapours, touching oil slicks and consumption of contaminated sea food. Exposure may cause neurological, ocular and also problems of respiratory systems. Ingestion of sea food which is contaminated with oil is dangerous as oil products have polycyclic aromatic hydrocarbons. These are carcinogenic in nature.

Vegetation

Oil spills also have impacts on vegetation. Different parts of the plants show different response to the oil spills. The root region is more vulnerable to oil spills. On the other side, coating of oil on the leaves shows no harmful response outside the growing season. Various organisms are dependent on sea grasses and other vegetation for their food and somehow if oil spills are released on the above, it causes loss of food chain. At the same time, living coral is also affected by oil slicks, due to which habitat of many fishes and animals is lost.

Mangrove

Though mangrove forests are in many ways adaptable ecosystems, they are highly vulnerable to oil toxicity and can be further damaged by many types of clean-up activities [9]. Mangroves often border coastlines where coral reefs live offshore, and these two ecosystems are closely linked. Mangroves filter and trap excess sediment that could harm coral, and coral reefs protect shorelines where mangroves grow from excessive wave energy.

Both habitats can be adversely impacted by oil spills, and spill responders must often consider trade-offs between land-based and offshore resources during a response. Figure 5 shows a mangrove.



Figure 5. Mangrove [9].

WHAT CREATURES ARE MOST AFFECTED?

Cetaceans, Sea Birds, Fishes, Sirenians, Marine Mammals, Sea Turtles etc. [10]

Figure 6(a) shows oil spills' effect on fishes and whales; and Figure 6(b) shows oil spills effect on sea otters [11, 12].

Oil, or hydrocarbons, can affect plants and animals in different ways. Oil spills can affect animals and plants in two ways: from the oil itself and from the response or clean-up operations. Spilled oil can harm living things because its chemical constituents are poisonous. This can affect organisms both from internal exposure to oil through ingestion or inhalation and from external exposure through skin and

eye irritation. Oil can also smother some small species of fish or invertebrates and coat feathers and fur, reducing birds' and mammals' ability to maintain their body temperatures.



Figure 6. (a) Oil Spills effect on Fishes and Whales [11].



Figure 6. (b) Oil Spills effect on Sea Otters [12].

Pinnipeds

Pinnipeds live in close proximity with earth surface as they are dependent on water for breathing. Soil adheres to fur of fur seals, thus their swimming ability is reduced and thus not able to move out of water, seal pups, mostly furry, are severely affected and soil make stick to their bodies, leading to *drowning or increased predation. As a result they are not being identified by their mothers*, so they are not fed or it might even reject attempts by the pup to suckle. This leads to starvation and abandonment [13, 14]. Figure 7 shows oil spills' effect on pinnipeds.



Figure 7. Oil Spills effect on Pinnipeds [13, 14].

Seabirds

Sea Birds reside for a longer period of time on or near spill affected shores. As a result of which their feathers collapse and matt which in turn reduce the ability of birds to fly. Sea birds lack weightlessness,

sink down and are drowned in water due to increased weight or due to scarcity of air trapped in feathers. Later as metabolism counteracts, the body weight decreases [10, 15, 16]. Figure 8 shows oil spill effect on sea birds [17, 18].

Marine Mammals

Marine mammals include sea otters, sea lions, seals, walruses, sea cows (dugongs), dolphins, porpoises and whales. As they are amphibious in nature, they are more vulnerable to oil spills, they also are migratory in habit so the negative impact of oil spills is to a lesser extent. Figure 9 shows oil spill effect on marine mammals [19].

Sea Otters

Sea otters depend on their fur for isolation as well as for floating. Oil spills result in reduced insulation. Also the inhaling hydrocarbons can damage their lungs, causing ulcers and also affect liver and kidney. One of the remarkable examples is of the Exxon Valdez incident which has led to death of more than 15,000 otters [4, 20]. Figure 10 shows oil spill effect on sea otters [21].

Polar Bears

Polar bears have thick fur and blubber that play a vital role in insulation. When the polar bear groom oil contaminated fur, oil is somehow swallowed by polar bear which result in even death of polar bear. This is due to inability of polar bears to produce red blood cells, which also causes damage to kidneys. Figure 11 shows oil spill effect on polar bears [22].



Figure 8. Oil spill effect on Sea Birds [17, 18].



Figure 9. Oil spill effect on marine mammals [19].

Sea Turtles

Sea turtles build their nests on sandy beaches. If somehow oil enters the food chain, it leads to damage in digestive system as well as other organs, it may also lead to inflammation of mucous membranes. Oil may also indirectly damage the eggs. Figure 12 shows oil spill effect on sea turtles [23, 24].

Cetaceans

Cetaceans have smooth body surface with less hairy growth, so changes of oil contamination are less. Baleen whales, which skim the surface are more likely to ingest oil than "gulp feeders" or toothed whales. Inhalation during surfacing could damage mucous membranes, damage airways or even cause death. Figure 13 shows oil spill effect on cetaceans [25, 26].



Figure 10. Oil Spill effect on Sea Otters [21].



Figure 11. Oil spill effect on polar bears [22].



Figure 12. Oil spill effect on sea turtles [23, 24].

LONG TERM IMPACT

Effects on Fragile Underwater Ecosystems

Global food chain can be affected which damages underwater ecosystem, killing many fishes and smaller organisms that are essential links in the global food chain.



Figure 13. Oil spill effect on cetaceans [25, 26].

Unbalanced Food Web

Oil spills if are more pronounced during breeding season, egg and larval populations are reduced thus causing harmful effects on food web as it happened during gulf oil disaster.

Decline in Recreation

Tourism is also affected as in Gulf States that fishing and recreation have been deprived of both from May to August leading to state park closures.

CLEAN UP AND RECOVERY FROM OIL SPILL

Booms

Booms are the large floating barrier that round up oil and lift the oil off the water (Figure 14) [27].

Skimmers

These are usually propylene mop-like pads that are placed on the ocean surface to adsorb the spilled oil film. Skimmers may be self-propelled, used from shore or operated from vessels. The efficiency of skimmers depends upon conditions at sea (Figure 15) [28].

Spraying Dispersants

From airplanes into the slicks, usually consisting in a mixture of surfactants and solvents which act like a soap and can be used to dissipate oil slicks (Figure 16) [29].

Bioremediation Accelerator

Oleophilic hydrophobic chemical containing no bacteria, which chemically or physically bonds to both soluble and insoluble hydrocarbons. It act as a herding agent in waters or on the surface, floating molecules to the surface of water, including soluble such as phenols and BTEX, forming gel like agglomerations. By over spraying sheen with bioremediation accelerator, sheen is eliminated with in few minutes [30]. Whether applied on land or water, the nutrient rich emulsion creates a bloom of local, indigenous, hydrocarbon producing bacteria. Those specific bacteria break down the hydrocarbons into water and carbon dioxide. Figure 17 shows a bioremediation accelerator [31].

Solidifying

The oil spills can be cleaned up with the help of compounds called as solidifiers which are basically polymers of dry hydrophobic substances and have capacity of absorption as well as adsorption. In this way they are able to convert liquid stage of spilled oil to semi solid or rubber like material that flats on surface of water. Solidifiers have been proved to be relatively non-toxic to the aquatic and wild life and have been proven to suppress harmful vapours commonly associated with hydrocarbons such as benzene, xylene and acetone [32].

Vacuum and Centrifuge

Vacuum helps in suckling oil along with water that can further be centrifuged thus separating oil spill from water.

Biological Agents

Use of micro-organisms to breakdown or remove oil. Such as bacteria *Alcanivorax* or *Methylococcus*.



Figure 14. Boom [27].



Figure 15. Skimmers [28].



Figure 16. Dispersants [29].



Figure 17. Bioremediation accelerator [31].

LEGISLATION

In order to ensure oil spill prevention, legislation is usually adopted. Such legislation usually targets the oil storage facilities and operator, enforcing regulatory compliance and the preparation of preventive responsive plans. Here are some legislation plans which have been implemented:

- i. The Clean Water Act establishes rules about water pollution [33].
- ii. The Oil Pollution Act of 1990 establishes the Oil Spill Liability Trust Fund to support Oil spill response.
- iii. The National Contingency Plan guides to avoid harmful effects of oil spills.
- iv. The Outer Continental Shelf Lands Act gives lease areas in federal waters for oil and gas development.

DISCUSSION

In addition to various physical and chemical processes, biological processes also occur simultaneously though at a slow pace. It includes the involvement of microorganisms which results in release of carbon dioxide or certain organic components which are in turn taken by large organisms for metabolism, storage and discharge. The duration taken for clean-up of spills may take weeks, months or even years. Oil spills at sea are more harmful as compared to land as the oil spills in sea can spread to every location.

CONCLUSION

Human activities are the major cause of oil spills as well as many serious accidents which can be avoided if precautions and proper care is taken. Focusing on use of spill prevention devices, preventive practices related to waste handling and disposal, *Corchorus depressus*, *Arachis hypogea*, Bentonite clay and activated carbon help in reducing the effects of oil spills on marine life.

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