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## **ENVIRONMENTAL IMPACTS OF MARINE OIL SPILL; A CASE STUDY OF DEEP WATER HORIZON OIL SPILL AT THE GULF OF MEXICO UNITED STATE OF AMERICA 2010 (A REVIEW)**

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### **ABSTRACT**

On 20<sup>th</sup> April, 2010, Deepwater Horizon oil spill occurred at the Gulf of Mexico, United States of America where large amount of oil spilled in to the water as a result of wellhead blowout from the rig. The spill marked as the largest oil spill ever in the USA and causes large impacts to the marine species and the surrounding environment which could last long after the spill. Petroleum consists of aromatic hydrocarbons (such as monocyclic and polycyclic aromatic hydrocarbons), which causes lethal and sub lethal toxic effect to the marine life and public health. The impact of the spill causes death and injury to many marine flora and fauna which could result to the disturbance of the ecosystem and may take long time before it recovers to its normal condition. Various methods were used to rescue the environment and the species but some methods (such as chemical dispersants, hot water) have side effects to wild life. Before the Deepwater Horizon oil spill, a number of oil spills occurred and caused large impacts to the marine organisms and the surrounding environment, and some impact are still yet to recover.

**Keywords:** Aromatic Hydrocarbons, Marine flora & fauna, Oil spill, Petroleum

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### **INTRODUCTION**

An oil spill is an accidental release of liquid petroleum hydrocarbon in to the environment due to human activity, and is a form of pollution. Oil spill can be on land where its impact can easily be eliminated. However, marine oil spills can result in oil pollution and causes serious environmental hazards, which lead to serious ecological risk and long term environmental disturbances. The major sources of oil spillage in to the sea are associated with oil transportation by tankers and pipelines. Large number of oil spills happened as a result of accidents of the tanker carrying the crude oil e.g. Exxon Valdez in 1989 at Prince William Sound (U.S.A) which was then recorded as the largest oil spill in United States of America, Braer 1993 at

Shetland Isles ( U.K), Sea Empress 1996 at Milford Haven, UK. However, apart from accidents, oil spills into the sea through tanker washing and other routing shipping operation (Clark, 2001) and causes large harmful effects to the marine species and the surrounding environment.

On 20<sup>th</sup> May, 2010, the Deepwater Horizon oil spill occurred at the Gulf of Mexico near Mississippi River Delta, USA. The oil spill was as a result of wellhead blowout, methane gas (CH<sub>4</sub>) from the well under high pressure blows all the way out of the drill column and expanded onto the platform and then ignited and exploded. Fire engulfed the whole platform and continued burning for approximately two days and the Deepwater Horizon sank into the sea after burning.



Fig.1 Deepwater Horizon prior to explosion  
Source: (WIKIPEDIA, 2011).



Fig. 2 Vessels combat the fire on the Deepwater Horizon after explosion (WIKIPEDIA, 2011).

Deepwater Horizon oil spill was the largest oil spill ever in the United States compared to the previous spills, like Exxon Valdez oil spill of Prince William Sound, in terms of volume of oil spilled and its impact to the environment and the indigenous biota as well as human health. Although, most of the workers escaped the rig explosion by life boats and helicopters for medical treatment but still eleven workers were missed

despite the coast guard search operation for some days, and are presumed to have died in the explosion. About 4,900,000 barrels (206,000,000 US gallons) of crude oil was estimated to have spilled into the sea and eventually spread on the water surface and coastal shorelines after some days, which covered an approximate area of 2,500 to 68,000 square miles (6500 to 180,000 km<sup>2</sup>) (WIKIPEDIA, 2011).



Fig.3 oil slick as seen from the space at Gulf of Mexico (WIKIPEDIA, 2011).



Fig.4 oil slick after dispersed by storm and water current (WIKIPEDIA, 2011).

The rate of spilled oil spreading on water depends on the sea temperature and nature of the oil; light oil spreads faster and to a thinner film (oil

slick) than heavy waxy oil (Clark, 2001). The oil spilled during Deepwater Horizon at the Gulf of Mexico is light in nature, and therefore most of the

lower molecular weight evaporated before it reached shorelines.

The aim of this paper is to discuss the Environmental Impacts, based on the short term and likely long term effects of the 2010 Deepwater Horizon oil spill in the Gulf of Mexico, on the surrounding natural environment and also the ways that may be followed to measure its impacts.

**Short Term Effects of Deepwater Horizon Oil Spill in the Gulf of Mexico and the Surrounding Natural Environment**

When marine oil spill happened, it usually causes immediate harm to the entire environment and living organisms present. Other consequences of the oil spill will follow after long period of time. These long term effects usually manifest to the

indigenous flora and fauna gradually as a result of changes in the chemical composition of the water (habitat) and physical alteration of the habitat (Neff, 2002). The short term effects of the oil spill manifest on the marine species, and leads to the high mortality rate and physical smothering due to the exposure to toxic effects of the oil (Dicks, 1998). A typical example of these short term effects happened during Exxon Valdez oil spill in 1989 at Prince William Sound (USA), which caused high toll of sea birds and marine mammal mortality as a result of oiling of plumage/fur, and death by drowning or starvation. The oil on the fur and feathers destroys the insulation value of the wild life and then causes them death by hypothermia. Ingestion of oil by the sea birds and mammals while trying to clean off their fur and feathers or scavenging



Fig.5: Heavily oiled Brown pelicans wait to be cleaned of Gulf spill crude.



Fig. 6. Wildlife was severely affected by the oil spill

on oiled dead animals, as the oil is a poison that can cause death or damaging their organs that lead to the long term effects. The common species found in the gulf region and the surrounding natural environments are sea birds such as brown pelican, sea ducks etc. Different species of fish and sea mammals, oysters, crabs, shrimps, turtles and

bay anchovies are also present. Other species live on estuary waters or wetlands, where about 75-90% of the creatures in the northern Gulf spend part of their lives; such important habitats for these creatures could be lost as a result of the oil spill and therefore results in the destruction of the ecosystem (Mascarelli, 2010).

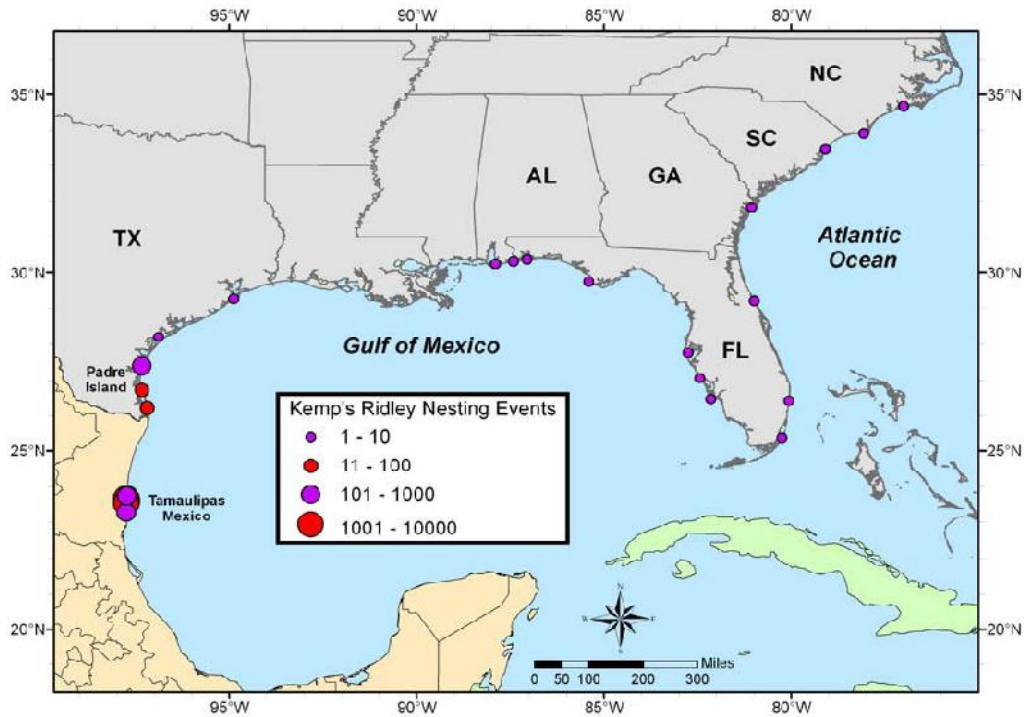


Fig. 7: Major nesting beaches in the State of Tamaulipas, Mexico, and proportion of total nests documented for each beach in 2007 (Source: J. Pena, GPZ), and location of nests recorded in U.S. (Source: Padre Island National Seashore, FWS, Florida Marine Research Institute, Georgia Department of Natural Resources, and North Carolina Wildlife Resources Commission).

Another problem that affected the ecosystem of the place was decrease in reproduction of many species due to destruction of their eggs and larvae by oil. Destruction of the environments ecosystem leads to the emigration and extinction of some species that are low in population. During cleanup process, different methods were used among which are dispersants. Dispersants cause oil to mix into the water column as small droplets thereby breaking up the size of slicks and removing oil from the surface and hence facilitate the biodegradation of the oil by microbes (Clark, 2001). Chemical dispersants, Corexit EC 9500A and EC 9527A were used to disperse the oil in the Gulf of Mexico, despite its quick action in

converting the oil into the form that can easily be biodegraded by the microbes, such dispersants are said to have toxic effects to the wild life and human health. Corexit EC 9500A and EC 9527A contain propylene-glycol, 2-butoxyethanol and dioctyl sodium sulfosuccinate. 2-Butoxyethanol was identified as casual agent in the health problems experienced by cleanup workers after 1989 Exxon Valdez oil spill (Carls, 1999, Schor, 2010). 2-Butoxyethanol may be a carcinogen to human since it has been shown to cause liver cancer in animals; it may also damage the developing embryo and therefore affects the female fertility in animals (WIKIPEDIA, 2011).



Fig.8. A C-130 Hercules drops an oil-dispersing chemical into the Gulf of Mexico

Similarly, dispersants mix the oil through the water column, increasing the exposure of marine organisms to the oil particularly in shallow water where there is possibility of having high concentrations of oil to reach the seabed and therefore exposing the organisms to the harmful concentrations of oil which could lead to death. (SEEEC, 1998, Samuel K., 1989).

#### **Likely Long Term Effects**

Petroleum is a complex mixture of hydrocarbon compounds usually with minor amounts of nitrogen, oxygen and sulphur-containing compounds as well as trace amounts of metal containing compounds (Speight, 1999). Petroleum consists of aromatic hydrocarbons such as monocyclic and polycyclic aromatic hydrocarbons, which cause lethal and sub lethal toxic effect to the marine life and public health (Maki, 1991). During the Deepwater Horizon oil spill, large amount of oil spilled into the Gulf area and spread across the water surface and shorelines. The likely long term effects that could result from the spill are physical and chemical alteration of habitats. The chemical alterations of the habitat is usually caused by increase in the concentration of chemicals such as aromatic hydrocarbons and metals-containing hydrocarbons from the spilled oil and therefore accumulate into the body of marine organisms, water and sediments and causes sub-lethal toxic effects to the organisms (Neff, 2002). Oil exposure to the marine organisms (birds, fish, crustaceans etc) resulted in lower growth rates, reproductive impairment and abnormal

developments in fish and reduced incidence of breeding and smaller eggs in sea birds. Such effects manifest gradually to the organisms, and after long period of time leads to the destruction of the ecosystem through the disturbance of the food chain as a result of low reproduction, extinction and even death of some organisms (Peterson, 2003). Similarly, the use of dispersants to disperse the oil during the spill even though is the quickest way to disperse the oil but may cause long term effect to the environment. Dispersants cause oil to mix into the water column as small droplets thereby breaking up the size of slicks and removing oil from the surface and therefore facilitate the biodegradation of the oil by microbes. After converting the oil in to small droplets and biodegraded by microbes, high molecular weight fractions which forms tar balls at the bottom of the ocean will continue affecting the benthos organisms for a long period of time. Some dispersants are also toxic to most marine flora and fauna and could wipe out many species including their eggs and larvae permanently which could result in the disturbance of the ecosystem (Schor, 2010). Gulf oil spill occurred in the deep ocean, about 1500m deep, therefore large amount of oil could be staying there for a very long period of time and harming the benthos organisms as a result of poly aromatic hydrocarbons (PAHs) compounds which can be accumulated in to sediments, organisms and the water itself.

Another likely long term effect of the oil spill is changes in biological communities which results from oil effects on the key organisms, for example

increased abundance of intertidal algae due to the death of limpets which usually graze the algae (Dicks, 1998). This environmental change could result in the alteration of the food chain and eventually leads to the death and emigration of many organisms, hence destructing the ecosystem. After the spill, oil incorporated in to the sub-surface sediments usually stay there for a long

period of time and is more dangerous than the surface one. Subsurface oil can remain dormant for many years before being dispersed and is more liquid containing high concentrations of toxic and biologically available polycyclic hydrocarbons (PAHs) (Carls, 1999). A disturbance event such as burrowing animals or a severe storm could rework the beach and re-introduces the un-weathered oil into the water and eventually affects the marine organisms (Peterson, 2003).



Fig.9.Toxic components of oil could stunt growth and cause mutations in crustaceans and fish in the Gulf, Source: (Mascarelli, 2010).



Fig. 10.A pit dug on a Prince William Sound beach in 2001 revealing oil in the sediments. Source:(Peterson, 2003).

#### How the Effects May be Measured

Measuring the extent of the deepwater horizon impacts might be a difficult task, but still there are some ways that can be followed to estimate some of the impacts. The first and the easiest way are by physical counting of the number of species that died during and after the oil spill and comparing them with the record of the available species present before the oil spill. This will help in assessing the total number of organisms that died. Periodic monitoring of the breeding colonies of some species (birds) will help in determining the extent of the impacts of the oil

spill; this can be done by observing the reproduction rate of some species such as sea birds. Similarly, certain analysis and examinations should be carried out to the affected sea birds and mammals in order to know the concentrations of some toxic components of crude oil (PAHs, monocyclic aromatic hydrocarbons and some metals) in organisms' body, which may cause mutation and stunt growth to the organisms; this can be done by analysing the blood and eggs of the animals as well as examination of the corpses to measure the PAHs level and compare it with those that are un affected by the spill (SEEEC, 1998).

Sampling and comparison of the oiled and non oiled areas of the birdsø species in terms of population decrease before and after the oil spill will also give clue to determine the extent of the oil spill impacts in the area.

### Conclusion

Oil spill is a disaster to the environment and its organisms which lead to the severe effects to flora and fauna as well as their surrounding environment. The impacts could have lethal toxicity (cause death) or sub lethal toxicity (causes effects) which can result in the disturbance of the ecosystem of the place. The spilled oil can stay very long in sub surface sediments in its liquid form and toxic containing biologically polycyclic hydrocarbons (PAHs) without been weathered or biodegraded.

The effects of oil spill depend on the nature of the oil, climate of the place and the organisms present as well as geography of the area. Light oil can easily be dispersed and evaporated before it reaches coastal shorelines, while heavy oil could not evaporate and dispersed easily and therefore cause long term effect to the surrounding environment and the organisms. The organisms living in the coastal shorelines are more vulnerable to the oil spill disaster as the coastal areas are difficult for cleanup.

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