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Short Term and Likely Long Term Effects of the 2010 Oil Spill in the Gulf of Mexico

Idris Rabiu
Science Officer, National Agency for Science and Engineering Infrastructure,
Idu Industrial Layout, Abuja, Nigeria

Abstract:
The Gulf of Mexico deep water horizon blowout occurred on April 20, 2010 and released about 4.6 million barrels (205.8 Million gallons) of light sweet crude oil. It arises from a well-controlled event which allowed hydrocarbon escape from the Macondo well located in Mississippi Canyon block 252, about 41 miles off the Louisiana Coast. The oil was released on to Transoceans deep water resulting in the expulsion and fire on the rig. The blowout was aided by the extreme conditions in terms of pressure (approximately 2240 psi), temperature (approximately 39oF) and flow. It's a hotspot of biological activities and supports a lot of industrial activities from fishing to tourism to oil and gas exploration. Some of the short term effects associated with the spill include damages to the environment, biological life (a large number if sea birds, fishes, mollusks, crustaceans, sea turtles, and marine mammals) and wildlife communities. The likely long term effects are dependent on the physical environment of the spill area as well as the extensive clean up processes employed. The effects are associated with chronic toxicity that is the long term sub-lethal effects of acute exposure.

Keywords: *Short term effects, Long term effects, Oil spill, Gulf of Mexico.*

1. Introduction

Oil spills can be classified as acute or chronic introduction of pollutants in to the marine environments. This has had a profound impact on indigenous populations and has altered the use of localized marine environments for significant periods of time (ERCO/Energy Resources, 1982). A few of the major oil spills have been subjected to comprehensive scientific study, among these are the Ixtoc 1 blowout of June, 1979 in the gulf of Campeche Mexico, the breakup of the tanker Amaco Cadiz off the coast of Brittany, France on march16, 1978, the Torrey canyon off the south coast of England, 1967(National Research Council, 1985). The Exxon Valdez which released about 37,000 tonnes of Phudhoe bay crude in to the subarctic environments of Prince William Sound, U.S.A in March, 1989, the Braer of January, 1993 which was wrecked on the southern tip of Shetland, UK (SEEC, 1998).

All the spills differ both on the fate of the oil and in their biological impacts. The extend of an oil spill depends on many factors which includes the volume of oil lost, this determines how serious a spill is in terms of clean up requirements and the impact on the environment. Other factors include the nature of the oil spill, weather and sea conditions and the physical and biological features of the spill condition. Seasonal conditions will also have an influence. (SEEC, 1998).

The deep sea horizon blowout occurred on the evening of April 20, 2010. It releases about 4.6 million barrels (205.8 million gallons) of light sweet crude exceeding the 1989 Exxon Valdez oil spill as the largest to originate in U.S waters and the 1979 Ixtoc 1 blowout as the largest spill on the Gulf of Mexico.

Figure 1: Geographical Map of the Gulf of Mexico

The blowout arises from a well-controlled event which allowed hydrocarbon to escape from the Macondo well, located in Mississippi canyon block 252 in the Gulf of Mexico about 41 miles off the Louisiana coast. The oil was released on to Transoceans deep water horizon resulting in expulsions and fire on the rig. The flame was fed by hydrocarbons from the well that continued for hours until the rig sank. Hydrocarbon continued to flow from the reservoir through the well bore and the blowout preventer for 87 days causing a large scale spill. The blowout was aided by the extreme conditions in terms of pressure (approximately 2240 psi), temperature (approximately 39oF), and flow. (ref: BP)


Figure 2, and Figure 3: Showing the Macondo flat form before and after the blowout

It was discovered when a large oil slick started to appear and expand around the rig site (ref 31 wiki). The oil's spread was initially increased by southerly winds caused by an impending cold fold. After some days, the oil has covered 580 square miles (1500 km2) and was close to the ecologically sensitive chandeleur islands, and covered about 3850 square miles (10,000 km2) by April 30. National Oceanic and Atmospheric Administration, and other related scientific bodies monitoring the spill with the aid of a satellite stated that oil has reached the loop current which flows clockwise around the Gulf of Mexico towards Florida and then joins the Gulf Stream along the U.S east coast (European Space Agency, 2010).

Figure 4: NASA Satellite image of the spill

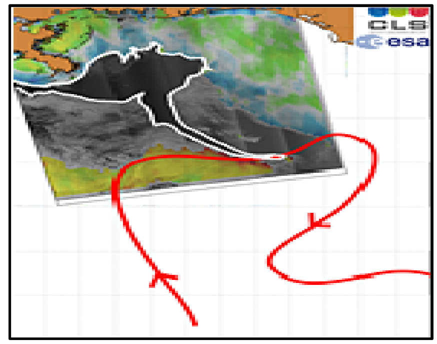

Figure 5: Current loop showing the direction of the slick

2. Short Term Effects

Short term impacts of oil spill can be severe, many organisms die as a consequence of oil spill, due to toxicity, hypothermia or smothery. Oil spills result in immediate effects which causes damage to the environment and biota. The deep water horizon is by far the worst in the U.S waters, the damage to the environment and wildlife might be less in the gulf as a result of some factors such as warmer waters and the fact that the oil leaked deep under water (The Independent Institute, 2010). Studies on previous spills shows great effect on marine life such as fishes and benthos, as in the case of Barge Florida oil spill, 1969. This shows an almost total eradication of the micro benthos at the site of the spill after 48 hours (National Research Council, 1985).

An initial assessment of the impact of the deep water horizon oil spill on biological communities of the area shows large number of dead seabirds, fishes, molluscs, crustaceans, Sea turtles, and marine mammals (Harte Research Institute for Gulf of Mexico, 2010). A large number of sea mammals such as dolphins were found dead and some acting drunk due to starvation resulting from the oil spill. A reasonable number of coral beefs could also have been smothered. More than 400 species in the Gulf became vulnerable such as the Kemp's Ridley turtles and other species of turtle. Oiled birds and the closure of the fishery are dramatic and an immediate effects of the spill. Methane gas gushing along with the oil could potentially suffocate marine life and also enhance the creation of dead zones where oxygen is depleted. (Wikipedia, 2010).

Figure 6: and Figure 7: Showing dead Sea Mammal and Seabird as a result of the spill

The use of chemical dispersants during the clean-up processes could also increase the toxicity of the spill and that sea turtle and blue fin tuna are exposed to even greater risk than the crude alone. It also increases the microbial activity resulting in the depletion of oxygen in the water. The toxic effect of the dispersants-oil mixture has manifested on bacteria and phytoplankton which makes up the basin of the Gulf's food web (University of South Florida, 2010). Although this was refuted by the National Oceanic and Atmospheric Administration (NOAA) which says the acute risk of the dispersants- oil mixture is no greater than that of the oil alone. (National Institute of Health, 2010).

Short term impact resulting from flammable and toxic fumes as a result burning during the clean-up processes possesses a major concern to the environment. Although the oil burned satisfactorily, there were question about the residual smokes which may give rise to irritation to the eyes and throats and raise toxic effects of the environment. This is similar to the case during the Exxon Valdez oil spill (Samuel and William, 1989). Furthermore, signs of oil- dispersant mixture were noticed under the shells of tiny blue crab larvae in the Gulf of Mexico, which is an indication that the dispersants have broken up the oil in to toxic droplets capable of entering the food chain. The orange blobs were found in almost all the larvae collected from the Grand Isle, Louisiana to Pen sacola, Fla more than 300 miles of coastline.

Figure 8: Crab larvae showing oil-dispersant droplets


Figure 9: Burning of oil slick taking place at the surface

3. Likely Long Term Effect

The long term effects of an oil spill are dependent on the physical environment of the spill area as well as the extensive clean-up processes that were carried out. These effects are associated with chronic toxicity that is the persistent exposure to a toxicant or the long term sub-lethal effects of acute exposure (Connell and Miller, 1984). Parts of the effects that can be caused the chronic exposure or sub-lethal effects of petroleum include disruption in energetic processes, interference with biosynthetic processes and structural development, and direct toxic effect on development and reproductive stages resulting in possible changes in population structure and dynamics. The indirect effect on a complex ecosystem, this might be substantial, an example is the destruction of the algal cover which had indirect impacts on the limpets and other invertebrates in the Exxon Valdez and Torrey Canyon oil spills (National Research Council, 2003).

A large boom of plankton is an indication of severe impact on the base of the marine chains. This was observed mostly in contaminated areas possibly indicating eutrophication effects or that the zooplankton species have been damaged. This would likely effect the exploitable populations of fish and shellfish. Similar effect was observed in some areas of the Gulf of Mexico after the Ixtoc 1 oil spill (Jernolov and Linden, 1981). The eggs and larvae of marine birds are very sensitive to petroleum hydrocarbon; they can be affected by oil slicks thereby increasing the threats to these stages and possibly the juveniles and adults. The potential damage to fish embryos may be long lasting as it was noticed in pink salmon species in streams traversing oiled beaches following the oil Exxon Valdez oil spill (Rice et al, 2001). Seabirds have the possibility of transferring oil from their feather to the surface of their eggs during incubation. This may lead to failure in the embryonic development of the affected eggs. Seabirds and mammals may be exposed to direct poisoning by ingesting oil when trying to remove it from their feathers or pelage, or when it sticks to food items. They can also inhale toxic doses of petroleum vapour when at the surface (Geraci, 1990).

Oil can also indirectly affect the survival or reproductive success of marine biota by affecting the distribution, abundance or availability of prey. This have been reported in some areas of prince Williams Sound where sea otters were removed by oiling their preferred prey, sea urchins have increased in some locations (Peterson, 2001). Also in Alaska were the population of sea urchins has rapidly increased in the absence of sea otters. (Allen and Kuhlmann, 1990) Another effect which persist long after the birds appear to have recover from oil exposure is the direct ingestion of oil or oil contaminated prey by seabirds, thereby resulting in immune-suppression and Heinz-body haemolytic anaemia which compromise the ability of the body to carry oxygen (Leighton et al, 1983) Several species tends to exhibit delayed response to spill especially those that forage on intertidal and shallow invertebrates or small fishes in inshore waters, this occurs to sea ducks and shore birds many years after the Exxon Valdez oil spill (Peterson, 2001).

4. Fate of the Oil

Researchers at the National Institute for Undersea Science and Technology (NIUST) discovered large oil plumes in the deep water of the Gulf of Mexico, about 10 miles long, 3 miles wide and 300 feet thick at a depth of 1000-1400 meters below the sea. Wood Hole Oceanographic Institute later confirmed that the plumes were from the Macondo spill. A large amount of oil was also found in the sediments of the DeSoto Canyon, a fissure that leads from the deep water horizon site to about 40 miles from Panama City beach by researchers from the University of California. They discovered the oil by shining ultraviolet light on the sample and indirectly detected hydrocarbons that have fluorescent finger prints as oils from BP well. The remaining oil can be accounted for through various clean-up processes employed during the spill, such as use of chemical dispersants, evaporation, skimmed, burned, removed, and natural dispersants. (National Council of Science and Environment, 2010).

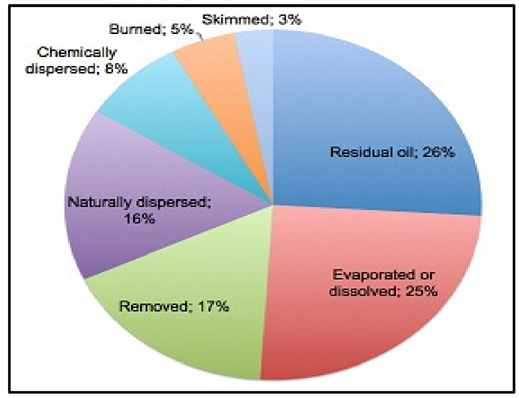

Figure 10: Gulp oil ultraviolet shining ghost crab *Figure 11: Graphical description of the fate of oil*

The toxicity of oil depends on the level of hydrocarbons present in the water column, volatile aromatic and lower molecular weight polycyclic hydrocarbon (PAH's) are the major constituent of oil that causes toxicity in the water column. The volatiles rapidly evaporate from the oil slick on the surface while the two and three ring PAH's and their alkylated homologues which are abundant in crude oils persist in the water column for a longer period in the water column thereby contributing to the toxicity of the oil (Neff and Stubblefield,1995).

5. Measuring the Impact of the Spill

The determination of oil spill effects requires various measures and interpretations of impacts and rate of recovery. Impact can be defined as a statistically significant difference between samples affected by the oil and reference samples (Wiens, 1995). Both impact and recovery must be considered in relation to the background of natural variation that describes marine environment. Measurement of spill impact can be done using various ways which depends on the rate of havoc caused by the spill. These include, Observations taken following spill with pre-spill data, this helps in assessing and considering the effect of natural variability in the evaluation of recovery. Although, this method is constrained by insufficient data because oil spills rarely occur in well-studied areas. It may also not capture the temporal variation of the system before the spill. Another way of measuring an oil spill impact is using data gathered following spill from oiled areas and unoiled areas surveyed at the same time. This method does not require pre-spill data. Impacts can also be measured by using measurements taken from sites along a gradient of oiling magnitude. The limitation of this method is the problem associated with finding suitable control areas which may lead to using a number of sites that differ in the magnitude of the oiling effects, but is suitable for determining impact on habitat rather than population size alone. (Wiens, 1995).

6. Conclusion

The impact of the deep water horizon blowout reached from the surface ocean to the sea floor in the Gulf of Mexico. This environmental disaster was in effect a large scale accidental experiment from which the scientific and environmental community learned a lot. Though, it has been established that oil and gas has been incorporated in to the Gulfs food web, the process by which the incorporation occurred is still unclear, and these will have a long term effect on the biological ecosystem. The overall impact of hydrocarbon exposure to the Gulf's offshore biological communities was extensive, identifying and understanding the exact effect will largely depend on the baseline ecosystem of the Gulf of Mexico which will aid in understanding the short and long term effect of the blowout. The effect of sedimentation as a major fate for discharged oil should be a source of concern and inform future response effects underscoring the need to quantify sedimentation rates across space and time; these would assist in constraining the fate of oil.

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