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THE RISKS, IMPACTS AND MITIGATION OPTION FOR ACCIDENTAL OIL SPILLS

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Abstract: ***A fully integrated and effective response to an oil or chemical spill at sea must include a well planned and executed post-incident assessment of environmental contamination and damage. While salvage, rescue and clean-up operations are generally well considered, including reviews and exercises, the expertise, resources, networks and logistical planning required to achieve prompt and effective post-spill impact assessment and monitoring are not generally well established. The arrangement and co-ordination of post-incident monitoring and impact assessment need to consider sampling design, biological effects, chemical analysis and collection/interpretation of expert local knowledge. This paper discusses the risks, impacts and mitigation options associated with accidental spills and considers the importance of pre-considered impact assessment and monitoring programmes in the wider response cycle. Project is considered as an example of an improved approach to the planning, co-ordination and conduct of post-incident monitoring. Increasing volumes of crude oil being produced and transported throughout the world in recent decades have resulted in increased risks of spill and high-profile spill incidents of significant environmental and ecological impacts over extended periods of time.***

Keywords: **Oil spill, Risks, Impacts, Mitigation**

INTRODUCTION

Oil spills endanger public health, imperil drinking water, devastate natural resources, and disrupt the economy. In an increasingly technological era, the United States has become more dependent upon oil-based products to help us maintain our high standard of living. Products derived from petroleum, such as heating oil and gasoline, provide fuel for our automobiles, heat for our homes, and energy for the machinery used in our industries. Other products derived from petroleum, including plastics and pharmaceuticals, provide us with convenience and help to make our lives more comfortable.

Spills of oils and chemicals in the marine environment remain a significant threat. Although there is evidence that the number of oil spills, for example, has decreased in recent decades the record is still regularly punctuated by large, high profile incidents. Furthermore, reports of smaller spills and potential incidents are occurring on a daily

basis. It also has to be recognized that for some areas of the world spill risk is probably increasing due to increased traffic. The situation for chemical, or hazardous and noxious substances (HNS), spill risk and incidents is less well defined than that for oils. Essentially the volume of transport of chemicals is less than that for oils but the wide range of chemicals transported includes some that, if released, have the potential for causing much greater environmental damage. [7]

IMPACT OF OIL SPILL ON ENVIRONMENT

A)Oil spills may impact the environment in the following ways:

Physical smothering of organisms: This is caused by oils with a high viscosity, in other words heavy oils.

Chemical toxicity: This is characteristic of lighter chemical components which are more bio-available, ie absorbed into organs, tissues and cells, and can have sub-lethal or lethal toxic effects.

Ecological changes: This is caused by the loss of key organisms with a specific function in an ecological community.

Indirect effects: Loss of shelter or habitat through oiling or clean-up operations.

B) Effectof oil on fish, birds, and mammals:

Fish:

Fish may be exposed to spilled oil in different ways. They may come into direct contact and contaminate their gills; the *water column* may contain toxic and volatile components of oil that may be absorbed by their eggs, larvae, and juvenile stages; and they may eat contaminated food. Fish that are exposed to oil may suffer from changes in heart and respiratory rate, enlarged livers, reduced growth, fin erosion.

Figure 1: Fish entrapped in oil spill [12]

Birds: Birds are very susceptible to oil spills. Seabirds, for example, spend a lot of time on the ocean's surface, dive when disturbed, and have low reproductive rates, making them particularly vulnerable to oil spills. In addition, the populations of species with small numbers of individuals, a restricted geographic range, or threatened and endangered species may be very adversely affected by oil spill contamination.

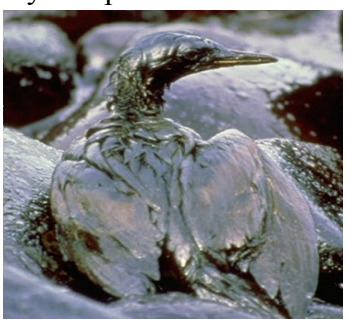

Figure 2: Bird entrapped and covered in oil spill [12]

Mammals: Mammals that may be affected include river otters, beavers, sea otters, polar bears, manatees, seals, sea lions, walrus, whales, porpoises, and dolphins. The sensitivity of mammals to spilled oil is highly variable. The amount of damage appears to be most directly related to how important the fur and blubber are to staying warm, which is called thermoregulation. River otters, beavers, sea otters, fur seals, polar bears, and land mammals need clean fur to remain warm.

C) Effects on the biomass:

In general terms, coastal areas are more sensitive than the oceanic areas, not only because of the complexity of the ecosystem and high biological production but also due to the intense use by humans. However, although these environments display distinct characteristics among themselves, many of the marine organisms, especially the fish, have an intimate relation with both of them. They utilize the coastal areas for reproduction, raising young, leaving for the open sea in the adult phase, but returning to them for the next reproductive cycle.

D) Effects of a general order:

Reduction in the fertility rate: Hydrocarbon products can reduce the quantity of eggs successfully fertilized.

Bio-accumulation: Some hydrocarbon compounds may be absorbed and accumulated by the outer skin, brachia, digestive tract and tissues of marine organisms, in concentrations greater than those found in the contaminated water itself, without directly causing their death, a process known as bio-accumulation.

Indirect sub-lethal effects (ecological death): Contaminated by hydrocarbons, the organisms may stop performing important functions in the ecosystems, as well as being capable of suffering damage to their physical integrity without dying immediately.

REMOVAL OF OIL SPILL

A) Mechanical Recovery: Skimmers and Separators

Once booms have concentrated oil in sufficiently thick layers on top of the water, mechanical methods such as skimming, separating and vacuuming can be mobilized where conditions are favorable. But because these techniques take place at the surface, they are subject to the same disruptions that applied to booms, particularly those posed by wind, waves and currents. Skimmers are slow yet very effective machines used for surface removal in calm or sheltered waters and along shorelines. They work by taking advantage of the adhesive nature of the oil, which will cling to any surface that it comes into contact with. Using rotation, suction, gravity or other forces to drive motion, these machines:

1. Provide a never-ending surface for the spilled petroleum to cling to,
2. Clean the surface, and
3. Repeat that process continuously.

Water can contain oil in three major forms:

1. Free oil (droplets larger than 20 microns in diame-ter),
2. Emulsified oil (droplets that have been mechanically or chemically reduced in size to smaller than 20 microns in diameter), and
3. dissolved oil (molecular-scale particles capable of dissolving in water).

Because they take advantage of the differences in the specific gravities of water and oil to achieve separation, traditional gravity-type separators will not separate emulsified or dissolved oil from water. A gravity separator has a chamber designed to provide controlled flow conditions that help globules of free oil rise to the surface of the water and form a separate oil mass that can be removed mechanically.

High-tech centrifuge separators also leverage the density difference between oil and water, but by using centripetal force to quickly spin and separate the two fluids, they can —slurp up as much as 200 gallons of oil every minute.

Mechanical collection by skimmers and sepa-rators cannot recover all the petroleum dumped in a major spill, a deepwater leak or a spill in rough waters where oil is rapidly churned and emulsified. These situations require chemical, mi-crobial and other more experimental types of intervention such as airplane-deployed robots that cordon off the oil and use centrifuge separators to collect oil for refining, non-toxic superab-sorbent polymer powder that forms a sponge-like material when sprinkled on an oil slick and is easily removed from the surface, [7] new high-speed skimming vessels that not only work fast, but can handle the rough seas that hamper current mechanical methods, and products like Aerogel, a reusable sponge-like material (composed of 2 percent clay, 2 percent plastic and 96 percent air) that's capable of absorbing oil and leaving water behind. [10]

B) Cleanup: Chemicals and Microbes

Dispersants: Dispersants are chemical formulations composed of solvents, surfactants and other additives that disrupt the solid surface of an oil slick by reducing the surface tension between oil and water. Composed of molecules with a water-compatible (hydrophilic) end and an oil-compatible (lipo-philic) end, dispersants link an oil droplet to nearby water molecules and allow the natural agita-tion caused by waves and wind to pull the droplets apart into increasingly smaller droplets. Unlike the large, free oil droplets that float in a two-dimensional slick at the surface of the water, these smaller droplets eventually become heavier than water and sink (spread in three dimen-sions) into the water column, or the vertical expanse of water extending from the sea surface to bottom sediments. Graham: Oil Spill Cleanup Once the decision to use dispersants has been made, there are additional considerations such as choosing the most effective commercial product and determining the optimal application system.

Whatever dispersant formulation(s) the agencies in charge of a spill select, they must design an application system (aboard aircraft or marine vessels) capable of meeting several basic criteria, including the ability: 1. to spray dispersant uniformly on the oil, 2. to disperse a droplet size that encourages mixing with the oil and ease of movement to the oil-water interface, 3. to attain the proper concentration at the oil-water interface, and 4. to deliver sufficient energy to disperse the slick into droplets. There is evidence that dispersed oil degrades more quickly than oil that has not been dispersed. So, ultimately, a successful dispersant operation would end in dispersed oil droplets being proc-essed in the marine ecosystem and degrading into naturally occurring substances. [9]

Microbes: Bioremediation may have a role to play in restoring oil-contaminated environments and habitats. But when it comes to using microorganisms and their enzymes to return areas to their original conditions, there are two opposing schools of thought. Many scientists agree that natu-rally occurring bacteria capable of degrading oil are already present in marine environments, but the limited availability of nutrients like nitrogen and phosphorus prevent the oil-eaters from per-forming to their full potential. Bioreme-diation isn't a practical approach far offshore, where high energy and waves can quickly dilute nutrients the microbes need to thrive. The final battle line, rescue and rehabilitation, comes after the oil has escaped containment, evaded cleanup and penetrated the living spaces of count-less marine and terrestrial wildlife species.[9]

CASE STUDY

The Mumbai oil spill occurred due to the collision between two cargo ships, namely, MSC Chitra and MV Khalija III on August 8, 2010 at Jawaharlal Nehru Port near the Mumbai port. This incident had a direct impact on the environment, marine life, fishermen, Indian economy and world trade. Indian Environment Minister, Mr. Jairam Ramesh has instructed to measure the depth of seriousness of the policy framework and the law against global warming in India. Legal action against the owners of both the ships has been taken.

In this incident, MSC Chitra tilted after collision and as a result of which the drums containing pesticides spilled the oil in the water. This accident occurred near Gate way of India which is a very popular tourist destination in Mumbai. This contaminated water reached Elephanta caves. Several fishes died, fishermen were asked not to go in the water and people were appealed not to eat the fishes during that time. This accident of the huge ship carrying tones of oil gave a threat of changed fish habitat, alteration of the land topography nearby and spilling of poison in the sea, the impact of which may last for decades.

The Energy and Resources Institute (TERI) developed oil zappers which were used over one kilometer area of the beach to treat the contaminated soil. The oi zappers feed on the hydrocarbon compounds available in crude oil and sludge and finally turn it into Carbon dioxide and water leaving pure and clean sand.

It was reported that 33 crew members from the ships were rescued except the policeman who was drowned from patrolling ship and the other three policemen could not rescue him as they did not know how to swim.

The surface temperature has already risen and this accident has contributed more to that. The increased temperature may result in death of endangered marine species. In warm water the marine species require more food and the plants they feed on in the seas and oceans die because of the global warming. The metabolism of these species also gets affected because of global warming. Global warming is responsible for changing the color of water in the ocean. Global warming is also responsible for destroying the key food nutrients required for the survival of the marine species. The sea plants helps in photosynthesis by converting carbon dioxide into organic carbon.

To overcome this oil spill accident and to save the water species it is required to protect not only them but the marine plants too because if these plants are alive the marine species will get food and nutrition and will ultimately help in clean, healthy and beautiful environment.

Based on the above mentioned case study:

1. Explain the role of Government and Business towards environmental protection.

2. Explain the effect of oil spill on the marine life and discuss how important it is for the business to protect the marine life.[8]

REFERENCES

[01] Adati Ayuba Kadafa , Oil Exploration and Spillage in the Niger Delta of Nigeria Civil and Environmental Research ISSN 2222-1719 ISSN 2222-2863 Vol 2, No.3, 2012

[02] American Chemical Society; Questioning the effectiveness of oil dispersants in Gulf oil spill. Energy & Ecology. July, 2010

[03] Dispersants: A Guided Tour - Part Four. National Oceanic and Atmospheric Administration 15)(NOAA), April, 2005 (revised October, 2008)

[04] Engr. Sylvester A. Egwu *, MNSE Oil Spill Control and Management Petroleum Technology Development Journal (ISSN 1595-9104) An International Journal January 2012 - Vol. 1

[05] Kietzman, Shannon. Oil Skimmers WiseGeek, June 2010 -

[06] Mundt, Bret. Oil Skimmers - Simple and Effective. Ezine Articles, June, 2010

[07] Megator Oil Skimmers. Megator Corporation, 2004

[08] Onojake M.C. and Okonkwo, V, Trace Metals Associated with Oil Spillage: A case study Journal of Chemical and Pharmaceutical Research ISSN No: 0975-7384 CODEN(USA): JCPRC5

[09] *O.T.* Badejo and P.C. Nwilo MANAGEMENT OF OIL SPILL DISPERSAL ALONG THE NIGERIAN COASTAL AREAS

[10] P.K. Andy Hong , Ting Xiao, Treatment of oil spill water by ozonation and sand filtration journal homepage: www.elsevier.com/locate/chemosphere Chemosphere 91 (2013) 641–647 S

[11] Peter C. Nwilo and Olusegun T. Badejo Mark F. Kirby , Robin J. Law Accidental spills at sea – Risk, impact, mitigation and the need

a. For co-ordinated post-incident monitoring

[12] P.K. Andy Hong , Ting Xiao Treatment of oil spill water by ozonation and sand filtration journal homepage

[13] Thompson, Derek. How Does Kevin Costner's Oil Cleaning Machine Work, Exactly? The Atlantic, June, 2010

[14] Upson, Sandra. Oil-Eating Microbes for Gulf Spill. Discovery News, June 11, 2010

