E-ISSN: 2347-5129
P-ISSN: 2394-0506
(ICV-Poland) Impact Value: 5.62
(GIF) Impact Factor: 0.549
IJFAS 2017; 5(5): 365-368

www.fisheriesjournal.com
Received: 18-07-2017
Accepted: 19-08-2017

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Impact of oil spill in the Bangladesh Sundarbans

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Abstract
The Sundarbans is the largest mangrove forest of the world which is a part of the world's largest delta formed by the rivers Ganges, Brahmaputra and Meghna. Different marine vehicles use this channel as transportation route and causes accidents but very few studies focused on this issue. After a devastating oil tanker accident on 09 December, 2014 based on field work this study identifies the character of the spilled oil, range of the spillage, impact of spillage on aquatic environment, mangrove and human. This study makes a contribution to present adverse impact of oil spillage through vehicle transportation along the Sundarbans. Alternative river transportation routes must be launched from Mongla port to other parts of the country as soon as possible. Training, equipment and experience will improve the response to environmental emergencies and reduce the impacts on local communities and ecosystems.

Keywords: Sundarbans, oil spillage, environment, human, river, transportation

Introduction
The Sundarbans is the largest single block of tidal halophytic mangrove forest in the world [1, 2] which is situated in the South-West area (21º 31′-22º 38′N and 89 º 00′- 89º55′ E) of Bangladesh and has been a Ramsar site from 1992, world heritage of UNESCO from 1997 [2, 3]. The Sundarbans covers approximately 10,000 square kilometers of which 60 percent is in Bangladesh and remaining part in India [4, 5]. In Bangladesh the forest cover 6017 km square area, where 4143 km square area are landmass and remaining 1874 km square area are water bodies in forms of a network of rivers, canals and creeks [6]. Among the areas 99% covered by the districts of Sathkhira, Khulna and Bagerhat and remaining areas are in Patuakhali and Barguna districts [7]. The forest area is very rich with natural resources especially floral and faunal diversity like 334 species of plants, 425 species of wildlife; including 40 species of mammals, 300 species of birds and 35 species of reptiles 177 species of fish, 24 species of shrimp and 7 species of crabs etc [6, 8, 2]. At least 5 million people are directly and indirectly depending on the Sundarbans for their livelihoods where 69% are involved with the aquatic resources, 22% people are with the collection of wood resources; 5% are involved with the non-timber forest product; and 4% are involved with other purposes [9].
Different cargoes and water vessels used 'Shelariver' as a river channel inside the eastern part of the Sundarbans for transporting all kinds of goods including oil from South-western area to other part of Bangladesh [2]. Mongla port authority and other officials mentioned this river as a unauthorized channel which was used due to siltation of the Mongla- Ghasiakhali- Morelgonj river channel [9]. On December 09, 2014, a tanker named (OT southern star which was carrying 75,000 gallons (357,664 liters) of heavy fuel oil (Black furnace oil) collided at around 5 am local time, with another vessel and partly sank in Shela river [2]. Within the one day, the oil has spread to cover more areas, at least 20 km upstream to Mongla and at least 20 km downstream to Horintana. Active tidal systems influenced the oil to reach into forest floors creeks and canals. The oil deposited on the soil, plants leaves, roots, pneumatophores, stems and floating fruits etc [9]. It is very important to investigate the adverse impact of this oil spill and this study deals with potential impact of oil spill on environment and human being living near Sundarbans.

Materials and method
Study sites
The study was conducted in three forest dependent communities of the Sundarbans. The communities were Chila, Paschim Chila and Joymonigul of Bagerhat district.

Livelihoods of these communities were mainly dependent on fisheries (90%) with diverse job portfolios such as fishing (main livelihood), fish drying, fish trading, net mending, boat making and repairing activity, as well as fuel wood, timber and thatching material collection.

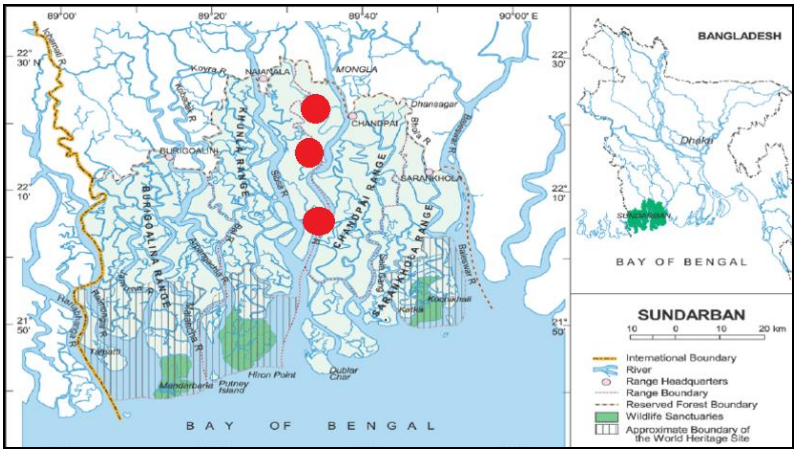

Fig 1: Map of the study areas

Data Collection

To collect empirical data, household survey and survey during fishing was conducted and a number of qualitative tools such as interviews, focus group discussions, and oral history were employed. Secondary data were mainly collected from Office of the Chief Conservator of Forest, Khulna. In addition, different scholarly articles and relevant literature was excerpted through online search. All of these gathered data were comprehensively reviewed, synthesized and relevant information have used in this study.

Result and discussion

Feature of Spilled oil

It was reported that 357664 liter furnace oil was released into the river. Furnace oil is a type of heavy fuel oil. While the exact composition of the oil needs to be chemically analyzed it is assumed to be close to that of intermediate fuel oil, IFO 380, which has a maximum viscosity of 380 Centistokes (<3.5% Sulphur) Its physical and chemical properties would change into water due to evaporation, emulsification, dissolution, photo-oxidation and biodegradation processes. Heavy fuel oil can be considered as less acutely toxic to the environment and human than lighter oils due to lower proportions of single ring aromatics (such as benzene) and smaller polycyclic aromatic hydrocarbons [10]. Aquatic sub-team of the UN-Govt. took different initiatives to find out the presence of non-visible oil. Sample of water, sediment and fish tissues were collected for visual analysis. Buried oil (oil within shoreline sediment) was found only in one site among the four sites of the rivers by the aquatic sub-team. No buried oil was also found in Crab holes of the most heavily oiled shore. Sunken oil was also not found during the use of weighted sorbent line on the river bottom [10].

Range of oil spill

The accident was took place among 14 villages of 4 wards named as Gabgunia, Paschim chila, Dakhin Joymonigul, Moddhya Joymonigul, Uttar Joymonigul in Chila union of Mongla Upazilla under Bagerhat district. A greater part of the surfaces of the rivers and canals of the South-eastern part of Sundarbans were covered by the oil layers. The spilled oil distribution was assessed through visual observation. Approximately 80 km of shoreline was assessed where 8 km (10%) was classified as having a high degree of oil [10]. Oil on the shoreline and on the vegetation less than 30 cm of coverage showed high level of contamination. Medium contamination was observed on a visible line of less than 30 cm on the vegetation and on human constructions. Low level of oil pollution was observed on the sporadic traces on the shore that formed a continuous thin layer of oil on the vegetation of less than 30 cm. No oil was observed along the shore but limited trace oiling cannot be fully excluded [10].

Oil removal action

Local people of these communities tried their best to collect the furnace oil. People started to collect the oil just after the occurrence of accident by considering not only its adverse impact but also for its economic value. They set net in the mouth of the canal so that the oil could not enter into the community canal network. Rope and fishing net were also used to scoop up oil. The UN and Govt. joint team reported that fine meshed mosquito net was very effective for removal of the heavy oil. Villagers collected oiled water hyacinth and grasses to collect released liquid oil by boiling theses without having any personal and respiratory protection. After boiling, vegetative material was gathered at three Department of Forest's assembly points named as Chandpai, Adharmanik, and Tambulbunia. Department of Forest reported that 200 fishing boats were hired to collect oiled vegetation from the riverbank. At first 30 taka and then 40 taka per liter was paid for recovered liters. BPC (Bangladesh Petroleum Corporation) noticed that a total of 68,200 liters was purchased from community members over ten days.

Table 1: Liters of oil purchased (UNEP, 2015)

Date	Oil collected (liters)
12 December, 2014	5,200
13 December, 2014	18000
14 December, 2014	17000
15 December, 2014	8200
16 December, 2014	7800
17 December, 2014	4600
18 December, 2014	4700
19 December, 2014	800
20 December, 2014	1400
21 December, 2014	500
Total	68,200

Representatives of the community were actively engaged in cooperation with Department of Forest for the identification of areas within the community where waste had been buried or stockpiled. Oiled debris and vegetation collected was deposited at various points throughout the community of Joymonigul.

Impact of oil spill on aquatic environment

Parameters such as organic matter, dissolved oxygen and hydrocarbons varied according to temperature, water turbulence, depth and salinity [11]. Phytoplankton population was highly sensitive to light soluble oil fractions. Only 18 Phytoplankton (Primary producer of food chain) species were recorded in the oil contaminated areas and abundance was very poor (24-67 units/l) but earlier 47 Phytoplankton species were recorded in the Sundarbans and abundance was 226 – 456 units/l. The results indicated that phytoplankton diversity and population/ abundance were affected by the oil contamination. Presence of *Euglena* sp. and *Phacus* sp. (pollution indicator) in oil contaminated areas also supported in the findings. Poor productivity of the oil contaminated areas also supported this finding [9]. Oil spill was also responsible for the depletion of the fisheries resources [9, 2]. Fishermen of the community also noticed the decreased of fish catch. Oil spill is responsible for the internal damage like blood and kidney damage of Aquatic organisms. 27 oiled animals (five frogs, two monitor lizards, two crocodiles, seventeen egrets, and one otter), were observed in the approximately two weeks following the spill[9].Water birds were also affected and became over-weighed that reduced swimming and flying capacity [12].

Impact of oil spill on Mangrove

The Sundarbans serve us with various ecosystem services like soil formation and protection, regulation of hydrological cycle, moisture contents, evaporation, climate and protection of the country from natural calamities [13, 14, 15, 2]. Sundarbans also support diverse biological resources [16, 17, 18, 19]. Oil from the fuel tank spread about 15 km downstream from the ship and affected a considerable part of the Sundarbans mangrove area. It was responsible for instant mortality of seedlings of *Heritiera sp* and *Excoecaria sp* [10, 9] while patches of grass which were covered by oil also died [7]. Nine creeks and four forest floor sites were assessed for oiling status, mangrove health, and potential clean-up measures. Oil found on vegetation was tested for mobility and potential routes for vertical penetration into the mud and crab holes were assessed. Eight of the nine creeks surveyed were classified as having low amounts of surface oiling on mangroves (i.e., leaves, trunks, prop roots, pneumatophores) and soil substrates. The vegetation in the remaining one was categorized as moderately oiled [10]. The spilled oil type, heavy fuel oil was considered to be less acutely toxic to mangroves, but could be more persistent in the environment over the long-term than lighter oil.

Impact of spilled oil on Human

Oil contains many compounds that could be harmful to humans, primarily volatile organic compounds (VOCs), including PAHs (Polycyclic Aromatic Hydrocarbons), as well as Sulphur- and nitrogen-containing compounds and metals. When oil is burned, additional PAHs can be formed as combustion by-products along with small dust particles. The dose and duration of oil exposure will directly influence human. The adverse impact includes eye irritation, subsequent blindness, throat irritation and headache. Ingestion of hydrocarbons can lead to nausea and diarrhea [20]. Community people also mentioned similar health problems during interview. Among 120 interviewee 45% mentioned they faced difficulty in breathing, 20% reported headache, 20% reported eye burning, 10% reported vomiting and 5% reported itching. People were got advice from the Department of Forest to use mask during oil collection but masks were not available in the local market.

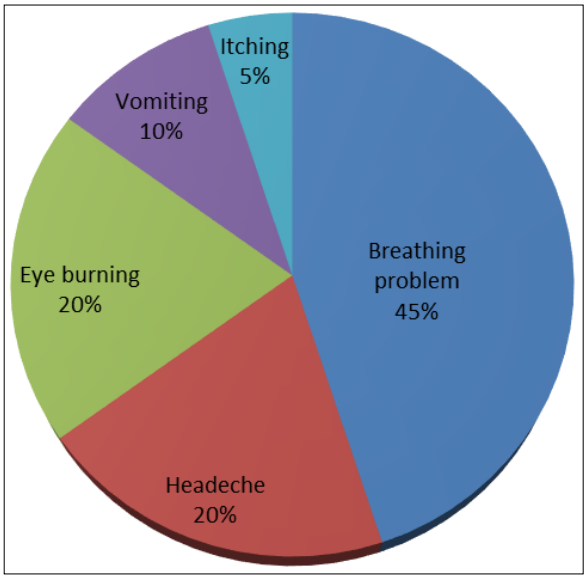

Fig 2: Impact of oil spillage on human

Impact of spilled oil on Livelihoods

Sundarbans is a resort of livelihood and support a large variety of wood and non-wood forest products that provide direct and indirect services [2]. Direct services include: construction materials (timber, railway sleeper, mining props, boat building, thatch, fence), fuel (charcoal and firewood), agricultural (fodder), fishing appliances (fishing stakes, fishing boat, tanning for net and fish), domestic use (glue), medicinal (treatment of ringworm, mange, sore throat and constipation) etc [21, 15, 2]. Most of the people mentioned adverse impact on livelihood due to oil spill during first two weeks after accident. A large majority of the interviewees reported damage to their fishing gear (90) and clothes (80%), 20 % reported the loss of domestic ducks and 10% reported that their drinking water supply and other sanitary facilities were affected.

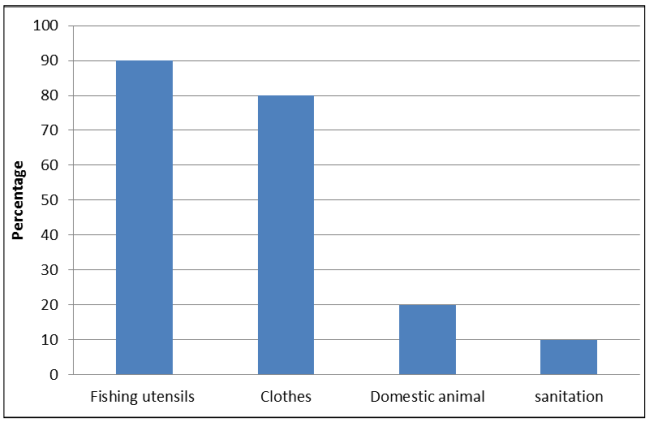

Fig 3: Impact of oil spillage on livelihood

Other forest resource (crabs, honey, fuel, fodder, wood, leaves collectors) collectors did not go inside the forest for the first two weeks since the oil spill. Respondents were not able to describe any impact of the oil spill on forest resources. However, communities have expressed fear that they may lose the opportunity to go inside the forest for collecting resources.

Conclusion

Oil spill incident within a wildlife protected area like the Sundarbans is very alarming due to substantial risk of adverse impact on both the environment and dependent communities. Appropriate mitigating measures should be taken to prevent such incidents again. It would be better if the cargoes and marine vehicle use alternative route for transportation so that alternative river transportation routes could launch from Mongla port. Monitoring should be stronger to assess any long-term or critical effect on biodiversity of the Sundarbans and dependent communities. Training and awareness rising program on importance of the Sundarbans, adverse impact of oil spillage on environment and dependent community could improve the situation by raising awareness among the community, officials of Department of Forest, vehicle owner, driver and labor

Acknowledgement

The author would like to express his gratitude to Dr. Mohammad Mahmudul Islam, Assistant professor, Department of Coastal and Marine Fisheries for his kind guideline.

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