

Impact of accidental leakage of furnace oil on Mahul creek mangrove vegetation

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A pipeline carrying furnace/black oil from Butcher Island to the petrochemical complex at Mahul in Mumbai started leaking during 3rd week of October 2013 and went unnoticed till first week of November 2013. The alignment of the pipeline is through an intertidal mudflat (0.240 km²) and about 0.052 km² area covered by luxuriant mangrove growth, mainly of *Avicenniamarina* (Forssk). On 36th day after the notification of oil spill incident, a field study was carried out to assess the impact on mangroves that were found dead due to smothering of their breathing roots with oil. Sediment core (40cm) samples were collected from the intertidal region showed high accumulation of Petroleum Hydrocarbons (PHc, 1496 µg/g wet wt) at 2 cm sediment depth. The concentration of PHc at 20cm and 40cm of the core was 25 µg/g and 58 µg/g wet wt. Such variation in the sediment core may be due to anthropogenic perturbation.

Mangrove wetlands are found along shorelines in tropical and subtropical intertidal zones of varying salinity¹⁻². Wherever present, mangroves are very vital to local ecology and economy. They provide a buffer zone to inland areas from devastating winds and deadly storm surges. Mangroves also trap and stabilize the sediment. Many birds use mangrove areas as roosting and nesting locations. According to the 1987 Survey³, the total area of the mangroves in India was around 6,740 km² covering about 7% of the world mangroves. But in a recent survey it is apparent that the total area of the mangroves decreased to around 4,500 km² which may be attributed mainly to deforestation, reclamation and pollution⁴. Indian coast is most

vulnerable to contamination due to oil spill⁵. Mumbai being a metropolitan city suffers from various anthropogenic and natural disasters due to port activities, marine operations including oil production and transportation which affects the marine ecosystem⁶⁻¹⁰. Hydrocarbons are the most important constituents of petroleum that arise from natural as well as manmade sources¹¹⁻¹². As hydrocarbons are released into environment they undergo various fates like volatilization, photo-oxidation, chemical oxidation, bioaccumulation, adsorption to soil particle, leaching, weathering processes, diagenesis and microbial degradation¹³. Mangroves are well known for their sensitivity to spilled oil, it was therefore anticipated that the mangroves would die due to suffocation and

smothering of the aerial root¹⁴. Oil dispersed on mangrove tree roots causes their death due to defoliation and loss in canopy density, malformation of fruits, sub-lethal biochemical and molecular damages¹⁵. We report mangrove destruction due to oil spill during October-November 2013, which has destructed around 0.052km² of mangroves in Mahul region.



Fig. 1— Map showing the location of study area.

Mahul Creek (18°59'N & 72°53'E) surrounded by mangroves is a tidal creek located on eastern margin of Mumbai metropolis (Fig.1) and this creek famous for migratory birds. Mahul Creek experienced oil spill event in October 2013 due to leakage in pipeline carrying furnace oil from Butcher Island to refinery (Fig.2a). Replicate Sediment sampling was carried out on 26 November 2013. Soon after collection, replicate core samples were carefully sectioned at 1cm interval from top (0-10 cm) and 2cm interval from

(10-40cm) portion. All these sectioned portions were preserved at -20°C till analysis. They were analysed by following the IOC-UNESCO procedure¹⁶. Each sample was tested for quenching by dilution as recommended¹⁷. The concentration values were calculated for sediments on wet weight basis using Saudi Arabian Mixed (SAM) crude oil as the standard. Samples of mangrove plants were collected from the impacted site they were identified to be fringing forest stands of *Avicennia marina* (Forssk) extending from the mid intertidal area to the upper intertidal limit. Tree heights varied from 3 to 5 m, and stem densities varied depending on the age.



(2a)



(2b)

Fig. 2— (a) Furnace oil pipelines from the sea to the refinery area, (b) Affected mangroves in Mahul Creek region.

The current study showed the impact of petroleum hydrocarbons released during oil spill which in turn affected the tropical mangrove ecosystem, the Impact can be seen in terms of burning of entire plants affected in the oil spill region (Fig.2b). Death of mangroves recorded from the affected area It may be due to smothering, hampering of photosynthesis, because of oil coated to leaves and suffocation of roots¹⁵. PHc concentration in the surface sediment samples from the intertidal region (TR-I and TR-II) and Subtidal region (stations 1, 2 & 3) average value ranged between 100.0 and 130.0 $\mu\text{g/g}$ and 6.0 to 20.0 $\mu\text{g/g}$ wet wt. It was observed that the levels of PHc in the intertidal sediment were relatively higher than the values recorded from subtidal sediments, indicating that the oil present in the aerial pneumatocysts roots of mangroves is sheltered on shore. Intertidal and Subtidal sediments are considered as the long term repositories for hydrocarbons released into the environment¹⁸⁻¹⁹. The vertical distribution of PHc is shown in (Fig.3). PHc in core sediment the average value ranged from 25.0 to 1496.0 $\mu\text{g/g}$ wet wt with maximum value (1496.0 $\mu\text{g/g}$ wet wt) at 2 cm of sediment core. It indicated build-up of PHc in the surficial sediment. As the core was collected about 1 month after the oil spill, seepage of oil in liquid form up to 4 cm was observed. The concentration of PHc at 20cm and 40cm of the core was 25 $\mu\text{g/g}$ and 58 $\mu\text{g/g}$ wet wt. Such variation in the sediment core may be due to

anthropogenic perturbation. Mortality or damage of mangrove plants due to oil contamination depending on the type, quantity and decomposed state of the oil, mangrove species, and prevailing metrological and tidal conditions²⁰. Generally, when the oil spill takes place in the open sea, it goes under several weathering processes or gets diluted before reaching the shore. However, in the present case, oil spill of thick furnace/black oil took place on the shore, impacting mangroves directly. From the information obtained from previous oil spills around the world, it is possible to suggest that impacts on mangroves in Mahul creek may continue for over a long period of time²¹. From this study it can be ascertained that impact of oil spill on mangrove ecosystem will damages the flora which may lead to loss in breeding ground and coastal erosion by various physical forces.

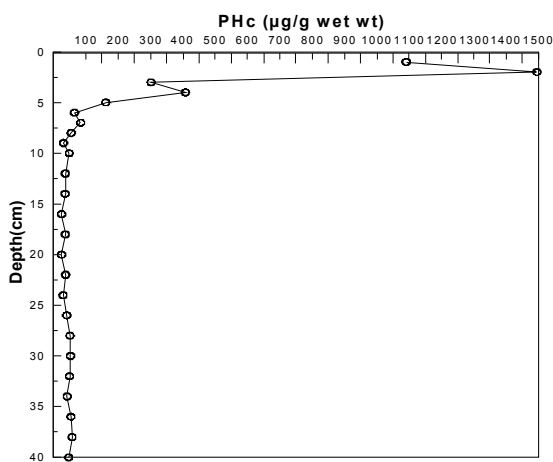


Fig. 3— The variations of Oil spill contamination of PHc in Mahul sediment core.

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