Oil pollution in Chilika lagoon: an anthropogenic threat to biodiversity

Chilika lagoon is situated on the east coast of India and is spread over three districts of Odisha, namely Puri, Khordha and Ganjam. The water-spread area varies between 1165 and 906 sq. km during monsoon and summer respectively[1]. It is a hotspot for biodiversity, and the largest wintering ground for migratory avian guests on the Indian sub-continent. It also boasts of some rare species such as Irrawaddy dolphins and Smooth-coated otters. The Nalabana Island in the central sector of the lagoon is a Bird Sanctuary and hosts migratory birds every winter. The lagoon is a highly productive ecosystem with rich fishery resources. It supports the livelihood of more than 2 lakh fisherfolk living in and around the lagoon[2]. In the last few decades the lagoon has been affected severely due to some natural processes like alteration of physico-chemical characteristics of water due to variations in climatic condition and desilting action of mouth of the lagoon[3] and anthropogenic inputs, viz. urban, industrial and agricultural waste[4,5]. This note describes oil pollution from mechanized vessels observed during regular field surveys (Figure 1).

More than 2 lakh fisherfolk derive their livelihoods from the lagoon resources. About 5089 non-motorized boats and 2259 motorized boats are used for fishing[6]. Moreover, a small number of these boats is used for tourism (dolphin-watching, temple visit, beach visit, Nalabana sanctuary trip) and about 5–6 jetties are used for both fisheries and tourism, and about 15 small boat-docking sites exist facilitating these movements[6]. Most of the motorized boats use petrol, diesel and kerosene as fuel along with engine oil. Apart from the fishing vessels, a motorized ferry operates four times a day between Satpada and Janhikuda, a maintenance dredger functions in different locations of the lagoon, boat services are offered by Odisha Tourism Development Corporation and local boats run through the day to transport people between Satpada and other locations in Chilika. These are some sources of leakage of petroleum oil into Chilika. Daily leakage of petrol, kerosene and engine oil from these motorized vessels due to poor maintenance and improper fuel handling is a cause of worry. The above man-made oil pollution can collectively be attributed to lack of awareness about environmental pollution, as well as boat maintenance protocols.

Oil leaks from motorized vessels may affect the lagoon environment and its biota directly or indirectly in Chilika. Petroleum oil contains volatile organic compounds which can partially evaporate by losing 20–40% of their mass becoming more viscous and denser, which provides more resistance to oil flow. Although a small percentage of oil may dissolve, the oil residue can disperse invisibly in the water and make a thick coating on the water surface. Oil also mixes with the suspended matter and sinks to the bottom. Toxic polycyclic aromatic hydrocarbons (PAHs) form a small fraction of crude and refined petroleum oil which remain in anoxic sediments after entering into aquatic systems[7,8] and can affect all aquatic organisms[9,10]. Formation of thick coating by the oil residue obstructs the photosynthesis of phytoplankton, which affects the total productivity of the lagoon.

Petroleum hydrocarbon (PHC) concentration of lagoon water was determined at four sites representing the four sectors of the lagoon (Figure 2). Three samples from each sector were collected during September 2013, analysed for PHC and the averages were considered as the representing concentrations for each sector. The Outer Channel was observed to have the highest PHC concentration (330 μg/l), whereas the Northern Sector had the lowest (50 μg/l) (Figure 2). PHC concentrations from the Central Sector and Southern Sector were 280 μg/l and 130 μg/l respectively. The Outer Channel of Chilika and the Central Sector have a high density of traditional non-motorized fishing and motorized fishing, and are also the centre of tourism activities, which might be the reason for these high PHC values compared to the other sectors. Presently observed values were concomitant with other studies indicating oil pollution due to increase in PHC concentration, viz. in the Arabian Sea (0.6–305 μg/l)[11], Visakhapatnam Harbour (11.5–123.8 μg/l)[12], Chennai Harbour

Figure 1. Field photographs of oil pollution in Chilika lagoon.

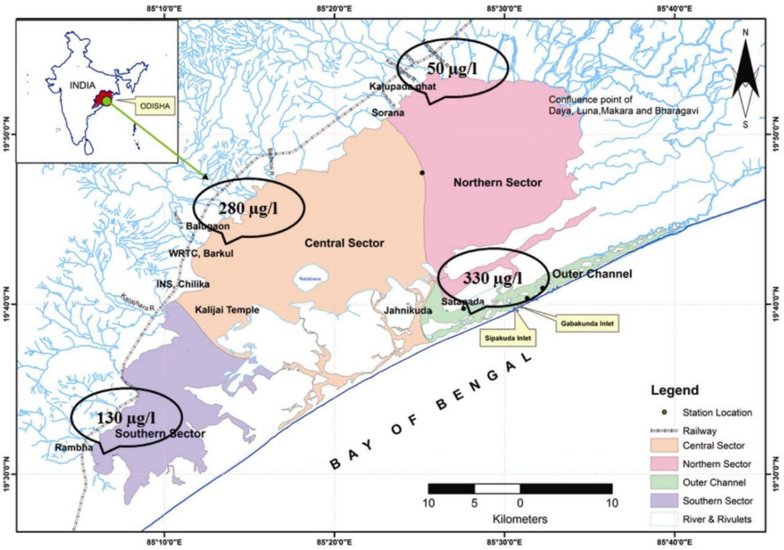

Figure 2. Petroleum hydrocarbon concentration at specified locations in different sectors of Chilika lagoon.

(11–139 µg/l)[12] and Chennai to Nagapattinam (14–1772 µg/l)[13].

Around 165 species and subspecies of birds representing 28 families are found in the Nalabana Bird Sanctuary[14]. They migrate from as far away as the Caspian Sea, Lake Baikal, the Aral Sea and other remote parts of Russia and the Himalayas to Chilika lagoon. Oil pollution can have an adverse effect on these birds and associated wildlife. Oil affects birds by coating their plumage, matting and misaligning their feathers causing problems with insulation[15]. Oil can also cause health issues for dolphins, which could cover their blowhole or enter the lungs[16]. The out-flux of oil-polluted lagoon water into the Bay of Bengal, through the Outer Channel, may be harmful to the nearby Olive Ridley sea turtle mass nesting site at Rushikulya estuary[2] and other aquatic life, specially fish which is one of the primary sources of livelihood for coastal communities in Odisha. Oil pollution has both short-term and long-term effects on the biota. Smothering, hypothermia and mortality are the short-term adverse effects on the flora and fauna. Whereas genetic abnormalities and changes in reproductive behaviour are the long-term effects when oil accumulates in eggs, embryos and body tissues of organisms present in different orders of the food chain. Hydrocarbon fraction of oil disturbs the stability of the ecosystem by affecting the respiration and the nitrogen cycle[17].

The key to solve this anthropogenic problem is the safe handling of fuels, engine oils and grease in motorized vessels. This can be accomplished by creating awareness among the motorized vessel owners and using administrative policies by the government. Oil spill removal by self-cleaning bacteria and bioremediation through fungi may be attempted[18,19]. Hazardous chemicals like organochlorine pesticides and polychlorinated biphenyls have entered into the lagoon predominantly via agricultural run-off[5]. So, keeping in view of the future adverse impact of oil pollution and hazardous chemicals on the lagoon ecosystem, this anthropogenic pollution should be regularly monitored and checked.

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