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Baseline

A case study on effects of oil spills and tar-ball pollution on beaches of Goa (India)

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ABSTRACT

This paper reports the impact of oil spills and tar-ball pollution on the coastal ecosystem of Goa. The factors responsible for degrading the marine ecosystem of the Goan coastline are analyzed. Uncontrolled activities were found to degrade the marine and coastal biodiversity, in turn polluting all beaches. This had a direct impact on the Goan economy through a decline in tourism. The government must adopt the necessary control measures to restore Goan beaches and the surrounding coastal areas.

The coastline of India spans approximately 8110 km. The states of Gujarat, Maharashtra, Goa, Karnataka, Kerala, Tamil Nadu, Andhra Pradesh, Orissa, West Bengal, and Tripura share the same coastline (Varkey, 1999; Sukhdhane et al., 2013). Goa is globally known to be a major tourist destination. Its main attractions include beaches with an approximately 105-km-long coastline and popular recreational activities. The majority of the Goan economy is dependent upon tourism (e.g., Dhargalkar et al., 1977). Mani et al. (2012) reported that Goas vast marine ecosystem is stressed by overfishing and destructive fishing practices, toxic pollutants, and climate change. Furthermore, oil spills and tar pollution add to these stresses. Presently, oil spills and tar-ball pollution have become a global issue, particularly in industrialized and developing countries such as India. Millions of liters of oil are discharged into the ocean yearly from routine ship and car maintenance activities, offshore oil drilling operations, and ship spills. Serious oil spills and tar-ball deposition on the seashore from these activities accelerate the degradation of marine ecosystems.

In the early 1970s, oil spills and tar pollution were reported in many ecologically sensitive and important regions of Goan beaches. These beaches were seriously affected as the pollutants were washed ashore by the water current. These oil spills attracted wide public attention as the tourism industry and the ongoing public recreational activities on Goan beaches, were hit. The Goa State Pollution Control Board (Goa) and the Government of India considered this an alarming environmental issue. Moreover, the marine ecosystem was systematically affected by oil spills and tar balls, as they are toxic and carcinogenic, leading to a decline in the coastal water quality and biodiversity health. In this context, as a part of a larger research project, the authors conducted a baseline case study of Goan beaches.

The objectives of the study are as follows:

1. To identify the sources of marine pollution
2. To study the extent of marine pollution caused by oil spills and tar balls
3. To estimate the impact of oil spills and tar-ball pollution on the Goan economy
4. To study the effects of temperature on oil spills and tar balls on the foreshore and backshore
5. To suggest policy measures to control/avoid or to clear oil spills and tar-ball pollution.

The state of Goa is located along the central west coast of India (latitudes 15° 48′ 00″ N to 14° 53′ 54″ N and longitudes 74° 20′ 13″ E to 73° 40′ 33″ E). Goa has a coastline of approximately 105 km, running parallel to the Western Ghats up to South Goa. The seasonal temperature varies from 20 to 37 °C from June to October (Wilson et al., 2014). In the present baseline paper, Goan beaches such as Arambol, Candolim, Chalanguate, Colva, Dona Paula, Miramar, and Singuerim were selected for investigating the impact of oil spills and tar-ball pollution on their respective marine ecosystems.

A field survey was implemented in the selected beaches (such as Arambol, Candolim, Chalanguate, Colva, Dona Paula, Miramar, and Singuerim). The observations obtained from the in-depth investigation of the study areas were cross-checked with the available published data (Fig. 1).

The negative impact of oil spills and tar-ball pollution was first reported in the 1970s by the director of the National Institute of Oceanography (NIO), Goa (India). On 2 July 1994, NIO reported an oil

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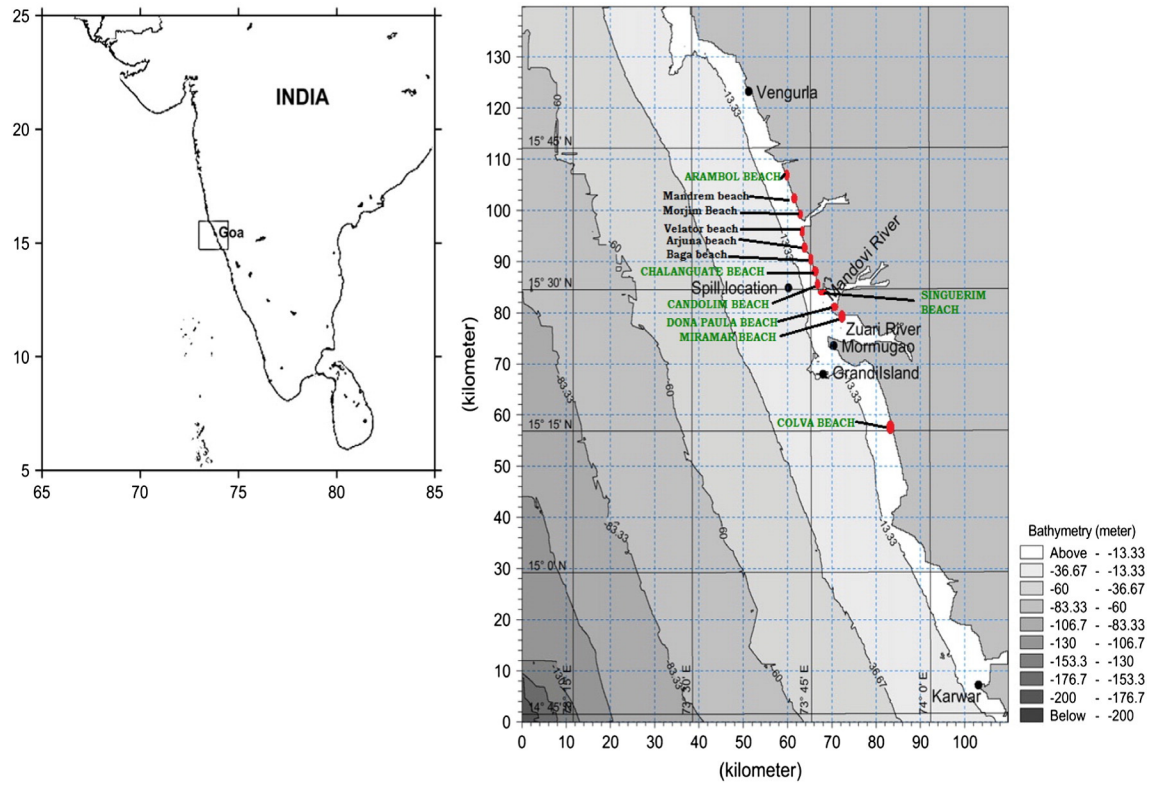

Fig. 1. Location of Goa and sampling locations at the Goan beaches.
Modified from Vethamony et al., 2007.

spill of approximately 2 tons from cracks on the starboard side of oil ships. The NIO also found oil slicks, partially degraded petroleum hydrocarbons, and residual tar in seawater and on beach sand (Fig. 2). The effects of all listed pollutants on marine algae, salt-tolerant bacteria, benthic meiofauna, phytoplanktons, and zooplanktons were observed (Desa et al., 1994). Although the impact of the oil spill reduced over time, several oil patches remained partially degraded and untreated. Oil spills and tar-ball deposits in seawater and on the sand were slowly degraded by resistant chemoheterotrophic microorganisms. However, several sensitive aquatic organisms, terrestrial flora and fauna, amphibians, and meiofauna were adversely affected. Simultaneously, the density of dominant nematodes and harpacticoid copepods significantly decreased. The major taxa were not adversely affected by the oil spill. An increase in population density was observed with the end of the monsoon and gradual degradation of the oil spill. Hence, oil spills and tar pollution were caused solely by oil leakage from ships and oil tankers, tanker washes, cracks on the starboard side, ship accidents, and benthic-zone oil spills. Ansari and Ingole (2002) stated that oil slicks and tar-ball deposition have been regularly observed for the past several years. Tar balls are generally deposited on the Goan coast during the pre-monsoon and southwest monsoon seasons. Oil deposition was reported along the Goan coastline during August 2010, April 2011, and May 2011. This was not caused by oil spill accidents in the Arabian Sea; instead, the main causes were oil leakage from cracks on the starboard side of ships, tanker washes, and the deposition of residual oil balls on the shore by cold seawater. To date, tar-ball deposition on the seashore is still observed.

Fig. 2. Dark streaks caused by tar balls lying on a South Goa beach during the last week of July 2005 (NIO, Goa).

Goan beaches from Colva (Margao) to Arambol were extensively surveyed to investigate the oil spills and tar pollution prevalent in the area. The flight distance (air distance) from the Colva beach (Margao) to the Arambol beach is approximately 52 km (Fig. 3). Large amounts of tar are deposited on the seashore every month by the year-round high tide and from June to October during the monsoon. The deposition of fresh and residual tar balls severely damages marine biodiversity, especially the lower taxa. Areas most hit by tar-ball deposition include an approximately 15-km-long stretch along the Salcete coast from Benaulim to Velsao, a 6-km stretch from Singuerim to Baga in Bardez, and important places of the Pernum coastline, especially in Arambol. The scenic beauty of other beaches such as Vegator and Miramar in North Goa and Khariwada and Cavelossim in South Goa was ruined by patches of weathered, particularly partially degraded petroleum hydrocarbon, arising from ship activities in harbors and ports. Tar balls of 100–300-mm size were observed. The width of the shoreline plays a significant role in tar-ball deposition on the seashore. Beaches such as

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