Summary and Conclusions
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Marine ecosystems constitute the largest aquatic system on the planet, covering over 70% of the Earth's surface. The organisms that inhabit the marine sediments constitute the largest faunal assemblages on Earth. The macrofauna (>500μm size) forms the dominant biomass of organism in marine sediment. They play an important role in ecosystem processes such as secondary production, nutrient recycling and pollutant metabolism.

A fundamental concept in ecology is the interaction between the organism and their environment. Studying the variability in communities at spatio-temporal scales, the impact of anthropogenic on the macrobenthic community can be assessed. Studies considering the community level response to pollutants and experimental disturbance are limited from the west coast of India. The importance of experimental disturbance on the communities or populations allows understanding the factors affecting the distribution and recolonisation of species. Experimental disturbance study should be done on communities or population and not on a single species. Furthermore, including the natural variability of ecosystems in experimental studies helps to better understand responses of communities to changes and discriminate between natural and simulated disturbance. Therefore, ecology of macrobenthic community along with simulated disturbance experiment have been attempted to gain a better understanding of the response of macrofauna to pollution, which was the main aim of this thesis. The present study focused on three major threats to the west coast of India viz., harbour activities, oil spill and sand mining.

Mormugao Port is one of the oldest ports on the west coast of India. It has a fine natural harbour and one of the best deep water ports in the Indian sub continent. Sampling was carried out at seven locations in the harbour, for environmental parameters and macrobenthos. Macrofauna of the area showed seasonal variation in dominance of species. The polychaete *P. pinnata* and *Tharyx* sp. dominated during monsoon which was replaced by the bivalve *T. scabra* in post monsoon. *Cossura* sp. was the dominant species in pre monsoon. Although *T. scabra* dominated the faunal community during post monsoon, it showed drastic decline in pre monsoon. A similar decline was observed in the other macrofaunal species. Therefore, the macrofaunal community in the harbour area did not follow the seasonal variation generally observed in the tropical estuaries.
Increased harbour activities during pre monsoon allowed only those species that can tolerate the stress to survive. The present data was compared with earlier published data from the region. The data indicates that the macrofaunal species have changed through the years. While the community was dominated by polychaetes in the present and past study, the major change was observed in crustacean, the second dominant group. The crustaceans in this study were observed only during the post monsoon and with low abundance. Even among polychaetes which dominate the macrobenthic community, the species composition showed shift from a carnivores dominated community to deposit feeding species. The shift may due to the change in the food availability in the area. The organic carbon showed an increase from previous reports. Increase in food may have facilitated the increase in the deposit feeding species. However, when compared to many of the other harbours around the world, the area did not show defaunation. This could be because of the strong hydrodynamic conditions in the Mormugao harbour, which flushes the contaminants out of the system and keeps the area well oxygenated. The heavy monsoonal runoff further helps in flushing the Zuari estuary.

Dredging is one of the major disturbances in the harbour and routinely carried out to maintain the navigable depth. One time dredging is carried out during the construction of new structures or extension of the existing one. The present study looked into the impact of one times dredging on the macrobenthic community of the Mormugao harbour and the time required by the community to recolonize. The sediment texture did not show significant variation at the dredged site after dredging. However, there was increase in suspended solids in the dredged station. The community in the dredged station was dominated by *C. scabra* which showed >90% decline as dredging progressed. However, decline in the macrofaunal abundance was observed in the adjacent and control station. However, it was difficult to assess the impact of dredging as the dredging was followed by monsoon season. The rough monsoon is known to cause the defaunation of the estuarine fauna, which is followed by recruitment in post monsoon. It can be concluded that one time dredging will have minimum impact on the macrobenthic community in areas with strong hydrodynamics. The impact of dredging on the macrofaunal community may occur only if dredging is carried out frequently as seen in the channel station. The channel station had lowest abundance and species richness through out the study period.
Studies comparing the macrobenthic community between different Indian harbours are limited. The present study was therefore conducted in three important harbour (Ratnagiri, Mormugao, Karwar) along the central west coast of India. This chapter discusses the health status of the three harbours diagnosed using various biotic indices. 55 macrobenthic taxa were identified. Biomass was high and was made largely by echiurans (>80%). Overall, polychaete dominated the macrobenthic diversity. Opportunistic *P. pinnata*, *Notomastus* sp. and *Mediomastus* sp., dominated the macrobenthic community responding to the increased in the harbour activities. Biotic indices (P:A ratio, ABC curve and geometric class abundance) and the dominance of opportunistic species indicate that, the three harbours are under stress from anthropogenic activities.

Oil pollution is a major environmental problem and is important, in particular, to the Indian coastline as two main ship routes pass through the Arabian Sea. Oil spills data indicates that accidental spills/accidents have shown an increase along the Indian coast. Aim of this chapter was to review the impact of frequent spills on benthic community and marine fishery, in general. Data was collected from various sources for the present work. Further, majority of the spills occurred during the SW monsoon period, which coincides with the recruitment period of most commercial and non-commercial species. Therefore, although the volume of spill is small, frequent occurrence and the occurrence during the crucial stage of the life cycle may have a long-term impact on the population of marine organisms.

India has some of the largest placer mineral resources in the world. Kalbadevi along the Ratnagiri coast in Maharashtra is reported to have rich deposit of illmenite - an ore of titanium. Although India has 35% of world reserve of illmenite, it contributes to mere 4% of the total production. Therefore, these areas with economical mineral deposits are potential site for future mining. The present work is part of an EIA study aimed to build up a baseline data of the macrofaunal community of the area. Seasonal sampling was carried out in the intertidal and subtidal region. Simulated mining experiment was also carried to study the immediate impact of mining on the coastal ecosystem and the time required for recolonisation in the disturbed site.
The intertidal and subtidal region of Kalbadevi showed a rich macrofaunal community. The macrofauna in the intertidal region was dominated by the gastropod, *U. vestiarium*. *Jasmineria* sp. *Mediomastus* sp. and *P. pinnnata* were the dominant species of the subtidal area. Unlike the Mormugao harbour, the community in Kalbadevi followed the conventional pattern in seasonal faunal variability. The one-time experimental disturbance carried in the intertidal and subtidal region showed minimal impact on the macrofaunal community. Further, the seasonal variability was superimposed on the simulated mining and hence it was difficult to demarcate the difference between natural and experimental disturbance.

It can be concluded that the west coast of India showed signs of stress from activities as evident from species composition, univariate and multivariate indices. However, the impact was restricted to the harbour area. This may be due to the location of the harbour towards the estuarine mouth. The hydrodynamic nature of the river helps to maintain the oxygen level. The heavy runoff during monsoon further flushes the entire estuarine system. Though the area is dominated by opportunistic species complete defaunation was not seen like many harbours.

The study also provides baseline data of the macrofaunal community from ilmenite rich area. The macrobenthic community was diverse and well represented by different groups. The simulated mining did not show detrimental changes in the macrobenthic community of the area as hypothesized before. The study also indicated that the community takes >1 year for recolonization. Commercial mining will not eliminate the macrofauna completely as long as the undisturbed area can maintain the population. However, the present data need to be interpreted with caution as the experiment did not reach the level of full scale mining experiment. Mining activities should be designed to minimize impact on biological resources and to ensure the biological assemblages that recolonize are similar to that present prior to mining. Facilitating rapid recolonization of a mined area would minimize alteration of community structure and function and reduce potential effect upon trophically dependent higher organism.
The importance of studying the spatial-temporal patterns of macrobenthic community is required as they form the basis for further work. The present study will contribute to our understanding the variability and management of the coastal ecosystem of India. Many of the species identified are well documented. However very little is known about their biology, reproduction and interaction with other species. Further, many of the organisms were not identified up to species level due to lack of literature. It is required to build a database of the macrofauna species for future management of this ecologically and economically important coast of the country. Developing such database will be a key to understand the ecosystem interactions and the processes that control regional and local biodiversity.

*Treat the earth well*

*as we do not inherit the Earth from our ancestors,*

*we borrow it from our children.*

*Ancient Kenyan Proverb*