Will shoreline armouring support marine biodiversity?

The imminent threat of climate change and the rapidly expanding population in coastal zones coupled with developmental activities in the coastal front has made the 'armouring' of coasts inevitable in India. With about 23% of the 7500 km shoreline along the Indian mainland affected by erosion[1], shoreline armouring, including seawalls, has become a necessary evil in the country. Seawalls are a common form of foreshore protection and are used both in estuaries and open ocean shores to protect against erosion, or as retaining walls for reclaimed land. In India, loose armour seawalls made of rubble (primarily granite) or concrete in the form of loose units such as blocks or tetrapods are commonly used.

Shoreline armouring has been reported to transform the nature of the substrate, reduce habitat for existing soft substrate species, create additional habitat for species from nearby natural rocky intertidal environments, and create novel habitat for introduced species[2]. Though it may be argued that seawalls may provide habitat for intertidal animals and plants, they do not support natural assemblages of biodiversity. Our studies comparing biodiversity of artificial and natural seawalls in the Kerala coast showed that many species occurring in natural rocky shores are either absent or found in differing composition in artificial seawalls, besides variations in the regeneration of communities in artificial systems. Thus construction of artificial seawall may affect the marine biodiversity, which is relatively abundant in the coastal waters of India.

The possible ecological impacts of shoreline armouring notwithstanding, different armouring structures, including pilings, breakwaters and seawalls act as the final refuge for coastal biodiversity and in some cases for urban biodiversity. One of the reported effects of seawalls on intertidal communities is the lack of habitat heterogeneity and complexity, reducing resources such as space and refuge and increasing competition and stress[2]. The artificial seawall built for the purpose of protection of shores as well as for protecting ports and other structures in the coastal zone may be capable of supporting a significant proportion of regional aquatic biodiversity, and in urban situations this region may serve as a shelter house of coastal biodiversity. Artificial structures may support various assemblages of organisms as they mimic natural habitat. This is particularly significant in the context of lesser importance given to marine biodiversity by conservation managers in India and considering the fact that 35 animal phyla are found in the sea, 14 of which are exclusively marine, whereas only 11 are terrestrial and only one exclusively so.

Even though shoreline armouring structures might surrogate for natural rocky shores, better understanding is required to analyse how these structures affect the processes and the assemblages they host and to enable the design of artificial structures that have a lower impact on the coastal ecosystems. Our survey indicated that in Kerala almost three-fourths of the sea coast is now protected by seawalls. Most of the seawall constructions in India have been initiated without detailed background studies on the geology and environmental settings of the individual beaches. With careful planning and designing, the shoreline armouring structures could be used to support local marine biodiversity by providing them with adequate habitat to settle and survive.

At present these structures are not designed or managed for the habitat they provide, and are built without considering the communities of marine organisms that could colonize them. Habitat enhancing marine structures (HEMS) are a potentially promising approach to ensure the habitats for biodiversity as habitat fragmentation and degradation are much more effervescent in coastal waters, especially in the cities. HEMS would improve the habitat quality of marine biodiversity and this could be incorporated in seawalls at the time of construction, renovation or even during designing shoreline armouring structures. If these innovations in structures are considered in the early planning stages of new construction and renovation projects by providing additional habitat types on seawalls, the biodiversity associated with it would definitely improve.

The use of ecological criteria in seawall design may mitigate some of the negative impacts of urbanization and development of shorelines while still serving societal needs of erosion protection and infrastructure support[2]. Artificial seawalls can create novel habitats which may affect the diversity, abundances, and distribution patterns of intertidal assemblages. Combination of concrete and artificial rock pools would facilitate enhancing biodiversity on seawalls, as these structures would serve as ideal fish-aggregating areas. The possibility of potential connectivity of seawalls with the environmental systems of adjacent water and land can also be explored to increase environmental benefit in these areas. In India, ecological and biodiversity considerations seldom feed the engineers as in the case of construction of dams. Some physical characteristics such as slope, crevices and texture that mimic natural intertidal substrate complexity can be integrated into future shoreline armouring structures and designs. In the era of green development and green economy, such ecological considerations in shoreline armouring would not only help in enhancing biodiversity, but would also provide new insights for achieving sustainable management of marine biodiversity.

1. Sanil Kumar, V., Pathak, K. C., Pednekar, P., Raju, N. S. N. and Gowthaman, R., *Curr. Sci*., 2006, **91**, 530–536.
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A. BIJU KUMAR*
R. RAVINESH

Department of Aquatic Biology and Fisheries,
University of Kerala,
Thiruvananthapuram 695 581, India
**e-mail: abiju@rediffmail.com*