

# Status of coastal biodiversity in the face of climate change with respect to islands

J K Mishra<sup>1,\*</sup>

<sup>1</sup>Department of Ocean Studies and Marine Biology, Pondicherry University, Brookshabad Campus, Port Blair, Andamans – 744 101, India

\*Corresponding author: jkmishra.omb@pondiuni.edu.in

**Abstract.** The ecosystem services rendered to the humankind is countless. However, the structural composition of these very ecosystems is under threat due to some unforeseen factors associated with the changing climate conditions. The island ecosystem, which is unique in terms of its endemic flora and faunal distribution pattern with ecological sustainability, is under tremendous pressure. In addition, its isolation from the main continental landmass makes them more fragile, unstable and highly vulnerable to any imminent changes occurring in their vicinity. The most common issues associated with them are biodiversity loss and probable threat to the bioresources of the islands due to several issues of concern about the climate change, sea-level rise, pollution, land stratification and several other anthropogenic activities. Islands too, have vivid form of ecosystems like terrestrial and aquatic (including both freshwater and marine), with heterogenic coastal habitats including sandy beaches, mudflats, marshlands, mangroves, creeks, grasslands, etc. But percentage of endangered species is very high in case of Islands, where factors like pollution, global warming, climate change, natural calamities and habitat utilization pattern play major role in this respect. In recent times, it has also been well documented that the variation in environmental conditions due to climate change impact and change in coastal geomorphology compounded with the sea level rise has become a matter of concern. This has invited enormous attention from think tanks from different walks of life to moot strategies for restoration and management of the coastal and island ecosystems.

## 1. Introduction

The natural resources are of paramount importance for the humankind as they provide innumerable benefits. Also, the services provided by natural ecosystems are unfathomable to measure. In any given ecosystem, bio-resources are represented by high diversity in accordance with varying geographical and ecological conditions encompassing different habitat structures of the concerned ecosystem. One such case is the coastal marine ecosystems, and these coastal ecosystems are the proud possessor of vivid bio-resources representing a healthy environment with the potential of providing innumerable services to humanity. However, their very structural composition is coming under some kind pressure from unforeseen and unpredictable changes in recent times, which is mainly attributed to the changing climate conditions on a global scale.



If we consider the Island ecosystem, which is found to be unique in terms of its endemic flora and faunal distribution pattern, the real aspect of climate change impact can be assessed. As suggested species endemism is higher in Islands, and their richness is mainly influenced by the specific island characteristics [1, 2]. Though Islands remain isolated from the main continental or subcontinental landmass, they have their own ecological sustainability with a healthy functioning ecosystem. Their isolation from the main continental landmass makes the island ecosystem more fragile, unstable and highly vulnerable to any imminent natural or human-made changes occurring in their vicinity. The most common issues pertaining to these changes with the Islands are the biodiversity loss and also the threat to the bio-resources of the Islands. This may be attributed to several issues of concern like climate change, sea-level rise, pollution, land stratification, anthropogenic activities, and biological invasions [3].

It has been found that Islands have a significant contribution to the ecosystem services and a high degree of global biodiversity, which they support due to the availability of the vivid form of ecosystems like terrestrial and aquatic (including both freshwater and marine) within the Islands. This includes rocky zones, sandy beaches, mudflats, marshlands, mangroves, creeks, grasslands, and other adjacent environmental conditions. All these heterogenic coastal habitats support vivid biodiversity and provide innumerable ecosystem-based services. Though these vivid bioresources have relevance in achieving the sustainable development goals [4], it may not be enough for a sustainable island ecosystem management as these resources are limited and are vulnerable to a high degree of exploitation.

## 2. Threat perceptions

It is well known that the biodiversity in any ecosystem is mostly affected by the imminent threats arising out of climate change, and it may have more influence in due course of time. The impact of climate change on the ocean ecosystems cannot be avoided, and it will have long term impact on the environment and humankind [5]. Similarly, the impact due to the loss of marine habitats dominated by seagrasses, seaweeds, mangroves, salt marshes or other coastal grassland ecosystems, etc. will bring much damage in terms of carbon sequestration [6]. It has been observed that the organisms, which migrate to narrow intertidal zone for breeding, feeding, nesting, etc. are facing the brunt of the change in this very environment as the intertidal habitats have degraded due to the impact of increased natural disasters, pollution, disposal of non-degradable pollutants like plastics and other litters and stratification strategy of changing habitats and this utilization pattern. The example can be derived from horseshoe crab breeding beaches as given in Figure 1 and the case of marine turtle *Lepidochelys olivacea* (olive ridley turtle) as given in Figure 2. Both of these endangered organisms mostly use sandy intertidal zone for egg-laying and nesting. The existence of a specific cue from the breeding beaches cannot be avoided, and the cue-based signal system may play a crucial role in orienting the brooders to the specific sandy intertidal zone [7]. Thus, the structural integrity of this unique fringe ecosystem is very important and needs immediate protective measures in the face of climate change and probable sea-level rise.



**Figure 1.** Breeding of *Tachypleus gigas* at Blaramgadi, Northeast coast of Odisha, Bay of Bengal.



**Figure 2.** The egg-laying process by *Lepidochelys olivacea* (olive ridley turtle) at an intertidal beach along the coast of North Andaman.

### 3. Present status of coastal biodiversity

It can also be presumed that some of the organisms may have evolved distinctive adaptive patterns to deal with any change in the environmental conditions. As a result, since the last millions of years of evolution, the organism has adapted to survive in specific environmental conditions. As intertidal environment has a high degree of biological diversity [8] and represents an astonishing glimpse of interactive life cycles of an array of organisms and indicate the health of the environment [9, 10]. However, a degree of the probable impact of climate change on the coastal biodiversity in island conditions is being observed [11, 12].

As per the IUCN red list species data, the percentage of endangered species is very high in case of Islands. There are several threats like pollution, global warming, climate change, natural calamities, habitat utilization patterns that also put a major threat to the island ecosystem. Particularly the coastal

areas adjacent to the sea remain prone to such activities as in the case of garbage brought the coast by tropical cyclones/storms, and associated erosion brings irreversible damage to the inhabited biodiversity in the coastline, particularly in the intertidal zone. It is thus the need of the hour that every possible effort should be made to protect these coastal beaches immediately from every possible threat as this environment not only act as a buffer zone between land and sea but also serves as a habitat for several migratory animals for feeding, breeding and nesting purposes. In recent times, it has also been well documented that the variation in prevailing environmental conditions due to the impact of climate change and change in coastal geomorphology compounded with the sea level rise has increased manifold. In addition, the island ecosystem and the intertidal environment, in particular, are under tremendous pressure due to a manifold increase in anthropogenic activities, which is the main cause of habitat loss. This has invited enormous attention to think tanks from different walks of life including scientists, environmentalists, and policymakers from all over the world to moot strategies for proper habitat restoration and management in the coastal and island environment.

#### **4. Probable measures**

In recent years, attempts are being made to reduce the impact of climate change in terms of managing the level of greenhouse gases released to the atmosphere. However, the loss of other major components like biodiversity, land degradation, ecosystem degradation vis-à-vis anthropogenic pressure in the name of sustainable development, etc. are becoming a major concern particularly in island conditions and requires immediate attention. Thus, the approaches made in this context should be inclusive of all ideas obtained from multiple practical approaches specific to the ecosystem conditions. Some of them may be like habitat utilization patterns in respect of the available biodiversity, consideration of protected areas and probability of ecosystem restoration with the involvement of immediate stakeholders and mainstreaming the biodiversity in terms of the ecosystem services they provide. These may stand good in conservation, sustainable exploitation, and management of bioresources in any given ecosystem, particularly the island ecosystem in the face of climate change.

#### **5. Conclusion**

The bio-resource diversity in the coastal zone is most vulnerable but highly significant both ecologically, socioeconomically and also due to their contribution in terms of ecosystem services they provide. However, this environment remains highly fragile due to varying environmental conditions. Though it has tremendous potential for a major source of food, raw materials for a different purpose, nutrient cycling, etc., this resourceful environment is encountering imminent threat due to the impact of climate change and anthropogenic interferences. This kind of interferences may bring substantial changes in the adaptive patterns of the organisms in the intertidal environment, particularly in the island environment condition. In this pretext, the island environment is more susceptible to any such kind of changes, which may occur in their immediate surroundings. Attempts may thus be made to understand any probable transition in the coastal demography about the changing climatic conditions. Its impact is also on the population dynamics along the coastline, which may be influencing the keystone species. Also, attempts should be made to assess the ability of the endemic population towards any adaptive evolution in response to climate change. To overcome, the probable response of biotic components to the abiotic components in the coastal island ecosystem may be taken into account for adopting a long-term strategy in the protection and conservation of Island biodiversity.

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