Training Resource Material

Coastal and Marine Biodiversity and Protected Area Management

Module 3

From landscape to seascape

For MPA Managers

भारतीय वन्यजीव संस्थान
Wildlife Institute of India

giz Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

On behalf of:

Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety

of the Federal Republic of Germany

Training Resource Material

Coastal and Marine Biodiversity and Protected Area Management

Module 3

From landscape to seascape

For MPA Managers

Summary

This brief but very important module provides an overview of the ecological, socio-economic and political context that make coastal and marine ecosystem management different from the management of terrestrial ecosystems. The module also summarises the key ecosystem characteristics of coastal and marine ecosystems.

Imprint

Training Resource Material:
Coastal and Marine Biodiversity and Protected Area Management
for MPA Managers

Module 1: An Introduction to Coastal and Marine Biodiversity
Module 2: Coastal and marine Ecosystem Services and their Value
Module 3: From Landscape to seascape
Module 4: Assessment and monitoring of coastal and marine biodiversity and relevant issues
Module 5: Sustainable Fisheries Management
Module 6: Marine and Coastal Protected Areas
Module 7: Governance, law and policies for managing coastal and marine ecosystems, biodiversity and protected areas
Module 8: Coasts, climate change, natural disasters and coastal livelihoods
Module 9: Tools for mainstreaming: impact assessment and spatial planning
Module 10: Change Management and connectedness to nature
Module 11: Communicating Coastal and Marine Biodiversity Conservation issues
Module 12: Effective management Planning of coastal and marine protected areas

ISBN 978-81-933282-5-5
December 2016

Published by:

Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH
Indo-German Biodiversity Programme
A-2/18, Safdarjung Enclave
New Delhi 110029, India
T +91-11-4949 5353
E biodiv.india@giz.de
W http://www.indo-germanbiodiversity.com

Wildlife Institute of India (WII)
P.O. Box 18, Chandrabani
Dehradun 248001
Uttarakhand, India
T +91-135-2640 910
E dwii@wii.gov.in
W www.wii.gov.in

Indira Gandhi National Forest Academy (IGNFA)
Post Office New Forest,
Dehradun - 248006
Uttarakhand, India
Phone +91-135-2757316
Fax +91-135-2757314
E-Mail : director@ignfa.gov.in

GIZ is a German government-owned not-for-profit enterprise supporting sustainable development.

This training resource material has been developed under the Human Capacity Development component of the project 'Conservation and Sustainable Management of Coastal and Marine Protected Areas (CMPA)', under the Indo-German Biodiversity Programme, in partnership with the Wildife Institute of India (WII) and Indira Gandhi National Forest Academy (IGNFA). The CMPA Project has been commissioned by the German Federal Ministry for Environment, Nature Conservation, Building and Nuclear Safety (BMUB) with the funds provided under the International Climate Initiative (IKI). The CMPA Project is being implemented in selected coastal states in India and focuses on capacity development of the stakeholders in the forest, fisheries and media sectors.

With guidance of:
Dr. Amita Prasad, Additional Secretary, Ministry of Environment, Forest and Climate Change (MoEFCC) Government of India
Dr. J. R. Bhatt, Advisor, Ministry of Environment, Forest and Climate Change (MoEFCC), Government of India
Dr. Konrad Uebelhör, Director, Indo-German Biodiversity Programme, GIZ India
Dr. V. B. Mathur, Director, Wildlife Institute of India
Dr. Shashi Kumar, Director, Indira Gandhi National Forest Academy, India
Dr. J. Michael Vakily, Team Leader, CMPA Project, Indo-German Biodiversity Programme, GIZ India

Compiled and edited by:
Dr. Neeraj Khera, Senior Advisor, Indo-German Biodiversity Programme, GIZ India
Dr. K. Sivakumar, Scientist F, Wildlife Institute of India

Text and editing contributions from:
Dr. Sarang Kulkarni, Marine Biologist, Indian Institute of Scuba Diving and Aquatic Sports (IISDA), Dr. J.A. Johnson, Scientist D, Wildlife Institute of India; Dr. Ramesh Chinnasamy, Scientist C, Wildlife Institute of India; Dr. D. Adhavan, Project Associate, Wildlife Institute of India; Dr. Pradeep Mehta, Research and Programme Manager, Earthwatch Institute India; Mr. Luke Mendes, Writer, Filmmaker and Media Trainer, Mumbai; Mr. S. Gopikrishna Warrier, Regional Environment Manager, PANOS South Asia; Mr. Darryl D'Monte, Chairperson, Forum of Environmental Journalists of India (FEJI); Dr. Dirk Asendorpf, Journalist and Media Trainer, Germany; Ms Atiya Anis, Communications Expert, Indo-German Biodiversity Programme, GIZ India; Mr. Sanjay Dave, Charkha and Mr. Bharat Patel, MASS Gujarat [case studies of turtle rescue and community plantation of mangroves]; Dr. R. Ramesh and team, NCSCM [ecosystem services, differences between terrestrial and coastal ecosystems, GIS]; Ms Helina Jolly [economic valuation methods and examples]; Dr. S. Senthil Kumar, IGNFA.

Photos by:
Dr. Neeraj Khera, unless otherwise credited

Disclaimer:
This training resource material is work in progress. The material in this publication is meant to be used for educational purposes only. It has been compiled, developed and edited by the named authors, contributors and editors and does not necessarily reflect the views of the GIZ or its partners. The master text has been created and compiled from documented and published references/resources. The master text has subsequently been edited and customized to develop training material for field-level MPA managers, senior MPA managers, IFS probationers, media students and trainers. While due care has been taken in preparing this document, the publisher, editors and text contributors assume no responsibility for the authenticity, correctness, sufficiency or completeness of such information or examples. Any geographical maps are for informational purposes only and do not constitute recognition of international boundaries or regions; publishers make no claims concerning the accuracy of the maps nor assumes any liability resulting from the use of the information therein. Any feedback and suggestions for improving this training material are welcomed at neeraj.khera@giz.de.

Table of contents

Key messages

- There are several types of coastal ecosystems in India: inland freshwater wetlands, inland brackish water wetlands, estuarine wetlands, coastal mudflats, sand dunes, rocky shores, mangrove forests, coral reefs and other coastal and marine ecosystems.
- There are no discrete boundaries in marine ecosystems as seen on land.
- Aquatic environments are richer in nutrients than equivalent terrestrial ecosystems and hence are able to support more life.
- Habitat destruction in the case of terrestrial ecosystems is widespread whereas it is localised in the case of the marine realm (estuaries, coral reefs, etc.).
- Degradation and destruction are 'visible' in terrestrial ecosystems whereas they may not be visible in the case of the marine realm.
- Property rights are much more complicated in coastal environments.

3.1 Coastal and marine ecosystems in India

According to the Indian naval hydrographical charts, the mainland coast consists of the following:

- 43 per cent - sandy beaches;
- 11 per cent - rocky coast including cliffs; and
- 46 per cent - mudflats or marshy coast.

Among the notable coastal features of India are the marshy Rann of Kachchh, in western India, and the alluvial Sundarbans Delta, to the east (which India shares with Bangladesh).

India has two archipelagoes: (1) the Lakshadweep, coral atolls off India's southwestern coast; and (2) the Andaman and Nicobar Islands, a volcanic chain of islands in the Andaman Sea.

According to the Zoological Survey of India, the Indian Ocean accounts for:

- 29 per cent of the global ocean area;
- 13 per cent of marine organic carbon synthesis;
- 10 per cent of the capture fisheries;
- 90 per cent of the culture fisheries;
- 30 per cent of the coral reefs; and
- 10 per cent of the mangroves.

Being landlocked in the north, and with the largest portion of it lying in the tropics, the Indian Ocean is a region of high biodiversity, with one of the countries in the region, India, rated as being one of the mega-biodiversity centres of the world.

In the current context of international trade and intellectual property regimes, it is important for all the Indian Ocean countries to understand their marine biodiversity.

The dissimilarities between the west and east coasts of India are remarkable. The west coast is generally exposed to rocky shore headlands with heavy surf, whereas the east coast is generally shelved, with beaches, lagoons, deltas and marshes. The west coast is a region of in- tense upwelling, associated with the southwest monsoon (May–September), whereas the east coast experiences only a weak upwelling, associated with the northeast monsoon (October–January), resulting in marked differences in hydrographic regimes, productivity patterns and qualitative and quantitative compositions of fisheries.

All the islands on the east coast are continental islands, whereas the major island formations along the west coast are oceanic atolls.

According to the Zoological Survey of India, the current inventory of coastal and marine biodiversity of India indicates that of 17,795 species from the faunal and floral communities have been reported from the seas around India.

The data reveal that India contributes 6.75 per cent to the global marine biodiversity.

India is one among the 12 mega-biodiversity countries and has 25 biodiversity hotspots of the richest and highly endangered eco-regions of the world.

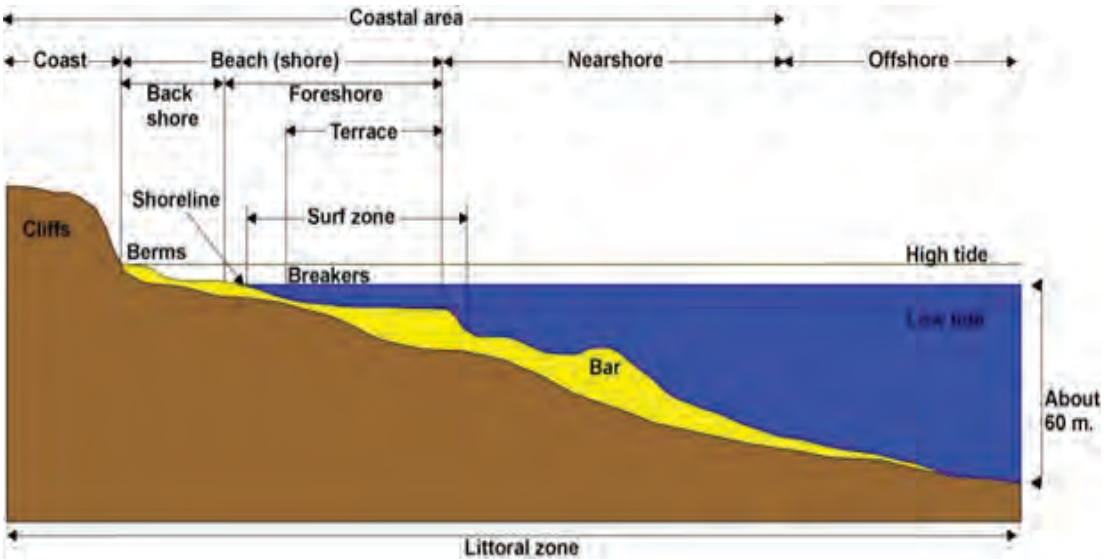
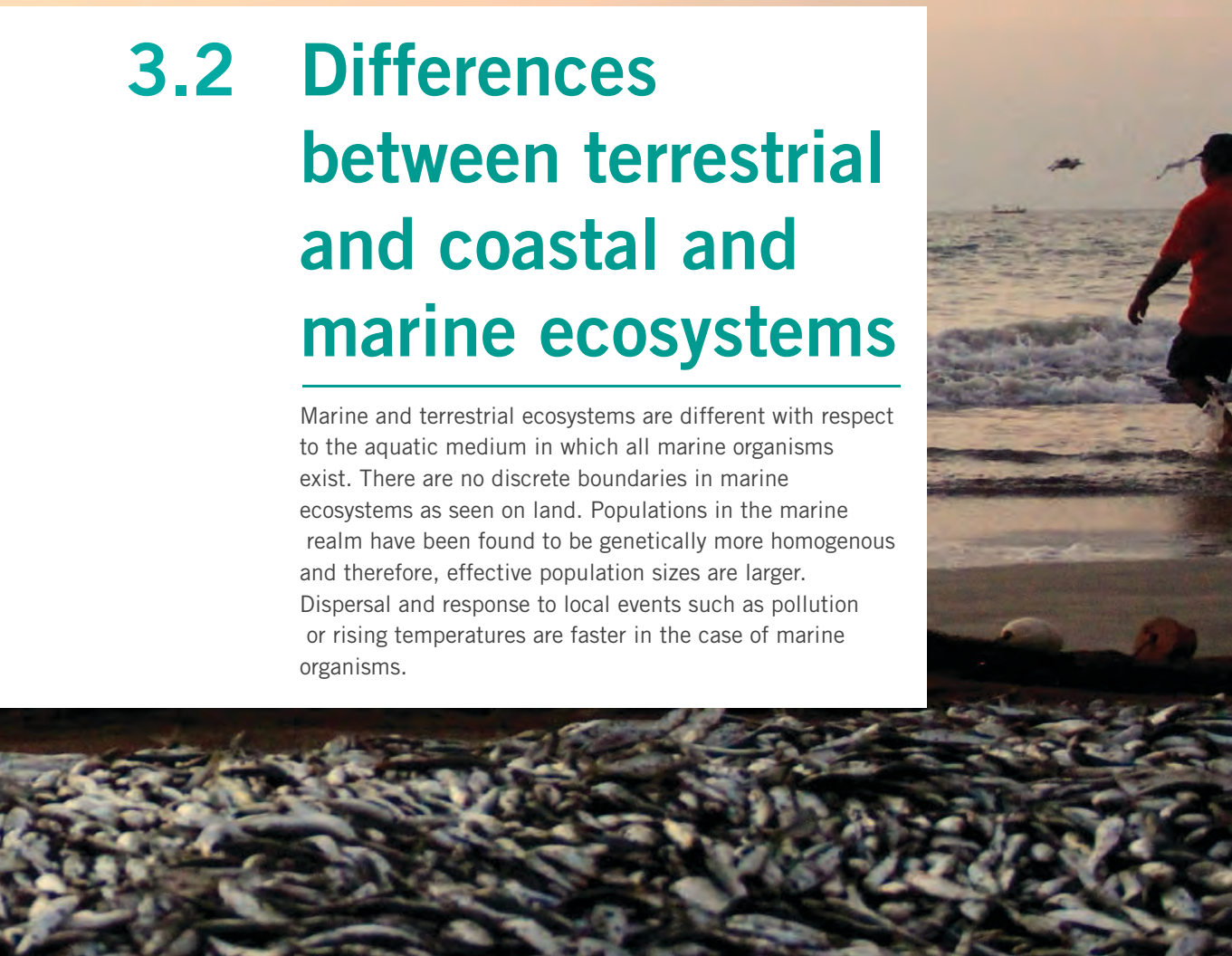


Figure 3.1: coastal and marine zones (Source: Lakshmi et. al. 2012)

3.2 Differences between terrestrial and coastal and marine ecosystems

Marine and terrestrial ecosystems are different with respect to the aquatic medium in which all marine organisms exist. There are no discrete boundaries in marine ecosystems as seen on land. Populations in the marine realm have been found to be genetically more homogenous and therefore, effective population sizes are larger. Dispersal and response to local events such as pollution or rising temperatures are faster in the case of marine organisms.



Degradation and destruction are ‘visible’ in terrestrial ecosystems, whereas, they may not be visible in the case of the marine realm. Only relatively recently have property rights been introduced in the marine realm (till now considered largely open-access), whereas they are well entrenched on land. Defining borders and patrolling them is much easier on land than on water.

According to Convention on Biological Diversity (CBD) Aichi Target 11, protected areas should be integrated into the wider landscape and seascape, and relevant sectors, bearing in mind the importance of complementarity and spatial configuration. Here landscape refers broadly to terrestrial ecosystems, whereas ‘seascapes’ refer to marine ecosystems.

The wider ‘landscape’ and seascape includes the array of land and water uses, management practices, policies and contexts that have an impact within and beyond protected areas and that limit or enhance protected area connectivity and the maintenance of biodiversity. The methods used in managing terrestrial ecosystems cannot be directly applied to marine ecosystems because of a number of reasons. These can be examined under the following broad contexts.

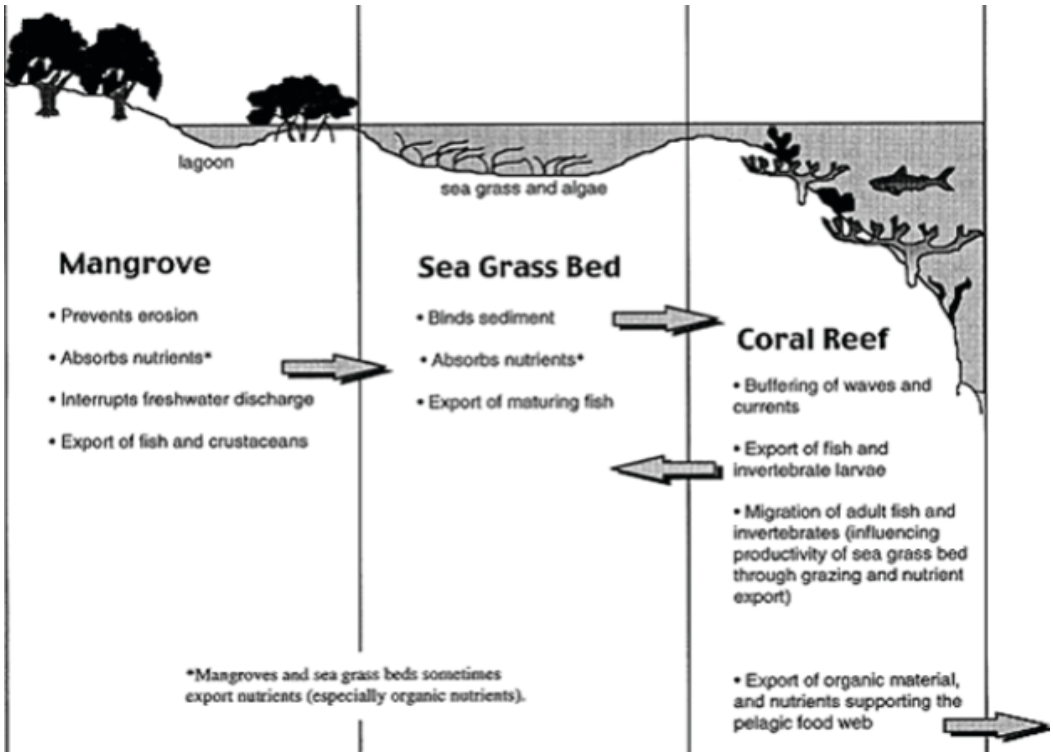


Figure 3.2 : From Landscape to seascape (Source: Moberg and Folke 1999)

3.2.1 Ecological context

The fundamental difference between marine and terrestrial areas is the aquatic medium in which all marine organisms live. Water being denser than air (800 times), organisms may be neutrally buoyant, have specialised floatation devices (e.g. swim bladder of fish) or have surface area to volume ratio to increase buoyancy. The buoyancy of water offsets the effect of gravity, which is why the largest animal on earth is a whale, an inhabitant of the marine realm. Terrestrial plants such as trees have to invest large resources in support structures (e.g. wood), whereas aquatic plants invest in fewer resources for support.

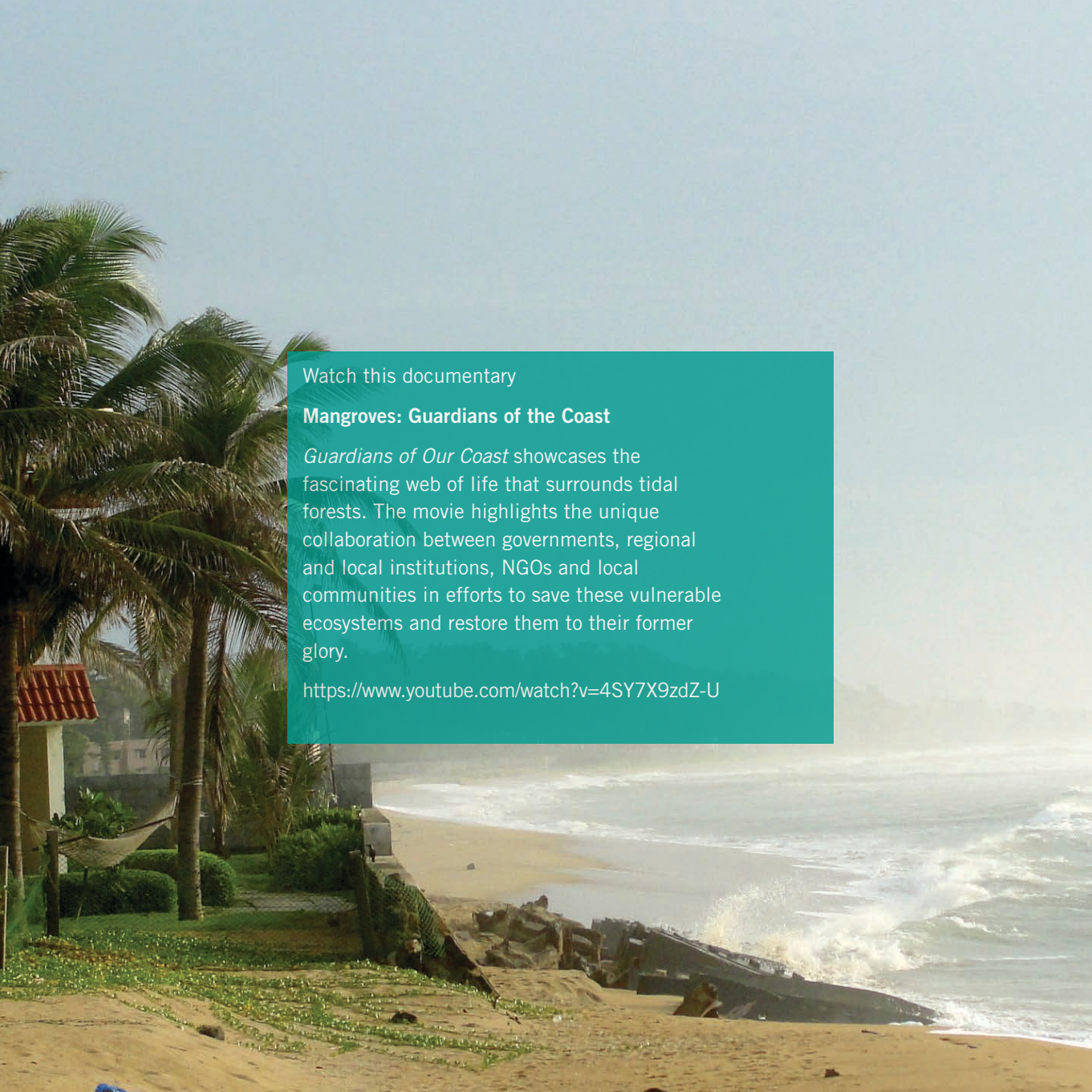
Plants, primarily the multicellular flowering forms, are the dominant primary producers on land, releasing oxygen through the process of photosynthesis. On land, plants are mostly sessile, rooted to the ground for their lifetime. In the marine realm, the microscopic unicellular phytoplankton are the dominant primary producers. These drift along with winds and waves, forming blooms where conditions (especially availability of nutrients) are favourable. Thus, on land, the ecosystems can be described as being more internally controlled by the dominant organisms (trees) whereas the organisms of the marine realm are subject to the physics of the surrounding medium, water.

Marine systems are highly dynamic, tightly connected through a network of surface and deep-water currents whose stratifications are broken by upwelling that creates vertical and horizontal heterogeneity. Consequently, the wide range of physical, chemical and geological variations that are found in the sea have given rise to a complex of marine habitats that range from highly productive near-shore ecosystems to the ocean deeps, which are inhabited only by specialised organisms.

Aquatic environments are richer in nutrients than equivalent terrestrial ecosystems and hence are able to support more life. However, while light and oxygen can be limiting factors in the aquatic environment, they are seldom so on land. The aquatic realm is relatively more stable than the terrestrial realm, with smaller fluctuations in temperature and other variables. Since they live in water, aquatic organisms are seldom exposed to desiccation, while terrestrial organisms are often exposed to desiccation. This is important considering the fact a large proportion of an organism's body is made up of water.

Perhaps the most important ecological point that needs to be considered in managing marine ecosystems is that terrestrial ecosystems have discrete boundaries while in the case of marine ecosystems the boundaries are relatively open. This is why it may be said that while the sea unites, land divides. This issue of boundaries is important in the context of migration of organisms and in the dispersal of organisms in various life stages. This has probably resulted in relatively lower genetic variation between populations and therefore larger effective population sizes. Apart from migration in search of food, marine organisms migrate as the local conditions change—the rate of response to environmental variability is much faster in the case of marine ecosystems compared to terrestrial ecosystems. The boundary issue is also relevant with respect to habitat fragmentation – the sensitivity to habitat fragmentation is much lower in the case of marine ecosystems.

There are also differences in the extent and importance of anthropogenic pressures. In the case of terrestrial ecosystems, habitat destruction is widespread, whereas it is localised in the case of the marine realm (estuaries, coral reefs etc.). Most importantly, in the case of terrestrial ecosystems, habitat destruction is 'visible' as in the cutting down of trees in a forest, while bottom trawling that may devastate the benthic habitat of marine ecosystems, may not be visible unless someone dives in the area.



Watch this documentary

Mangroves: Guardians of the Coast

Guardians of Our Coast showcases the fascinating web of life that surrounds tidal forests. The movie highlights the unique collaboration between governments, regional and local institutions, NGOs and local communities in efforts to save these vulnerable ecosystems and restore them to their former glory.

https://www.youtube.com/watch?v=4SY7X9zdZ-U

3.2.2 Socio-economic context

Property Rights and Ownership

In the socio-economics context, the different kinds of property rights become relevant in understanding the difference between marine and terrestrial ecosystems. On land, property rights are reasonably clear: private, public (state) and common property. In contrast, coastal waters and many coastal spaces such as beaches have always been considered open access, which means that restricting natural resource-based activities such as fishing, seaweed collection and shell collection can be difficult as it will affect thousands of livelihoods.

At the international level, it is only after the United Nations Convention on the Law of the Sea (UNCLOS) that nations have acted to establish ownership of the seabed and overlying waters by declaring territorial waters and the Exclusive Economic Zone (EEZ). While the onus of conservation of living marine resources in the EEZ vests with the coastal state, Section 2 of Part VII of UNCLOS broadly states that states should cooperate with one another in the conservation and management of living marine resources in the high seas. Most recently (2011), the Global Environment Facility (GEF) project on Areas Beyond National Jurisdiction (ABNJ) was developed to promotes efficient and sustainable management of fisheries resources and biodiversity conservation in the ABNJ, considered as the world's last global commons.

More than a third of the world's population lives in coastal areas and small islands, which make up just over 4 per cent of earth's total land area. Fisheries and fish products provide direct employment to 38 million people. Coastal tourism is one of the fastest growing sectors of global tourism and provides employment for many people, generating local incomes. Ninety per cent of world trade is through sea shipping.

Food Chain

Marine ecosystems have been important as providers of food for millennia, especially for those living in coastal areas. While the proportion of farmed food with respect to wild-caught food is very high in the case of terrestrial ecosystems, it is capture fisheries that dominate production from the marine environment. In terrestrial environments, it is primary producers and herbivores, the first two levels in a food chain/web that are farmed and consumed, whereas in the case of food from the sea, it is the carnivores or organisms at higher levels in the food chain that are harvested and consumed. Depletion at the higher trophic levels can have a cascading effect on the food chain and food web. This can be considered as the second relevant point of difference between marine and terrestrial ecosystems from a socio-economic context.

3.2.3 Political and security context

Land borders are geographical features such as rivers, seas, mountains and other formations that present natural obstacles to communication and transport. Existing political borders are often a formalisation of these historical, natural obstacles. While some borders (between countries) are open and completely unguarded (e.g. inter-state borders within the Schengen area in Europe), most borders between countries are fully or partially controlled and may be crossed legally only at designated check points.

Deliberate (human) movement of plants and animals across borders may be prohibited (in the case of endangered species) and is otherwise usually restricted through quarantine requirements. However, migratory movement of plants or animals (in which a significant proportion of the members of the entire population or any geographically separate part of the population cyclically and predictably crosses one or more national jurisdictional boundaries) is historically unrestricted and is the subject of the Convention on Migratory Species.

With respect to maritime boundaries, under UNCLOS, a coastal state is entitled to a territorial sea not exceeding 12 nautical miles measured from its baselines. Within its territorial sea, the coastal state exercises sovereignty, including over its resources. Subject to the provisions of the convention, ships of all states enjoy the right of innocent passage through the territorial sea. The convention also grants a coastal state the right to establish a contiguous zone not extending beyond 24 nautical miles from the baselines. Within its contiguous zone, the coastal state may exercise the control necessary to prevent and punish infringement of customs, fiscal, immigration or sanitary laws and regulations that have occurred within its territory or territorial waters and to control, in specified circumstances, the trafficking of archaeological and historical objects.

In addition, a coastal state may establish an Exclusive Economic Zone not extending beyond 200 nautical miles from its baselines, where the coastal state has sovereign rights for, inter alia, marine scientific research and protection and preservation of the marine environment. When two or more coastal states share a sea or ocean, usually bilateral/ multilateral treaties are executed to resolve border disputes.

On land, hunting in border areas can be controlled: hunters chasing their prey may be stopped by clearly demarcated natural or artificial borders which allow their prey to move away but clearly indicate the limit of human movement. On the other hand, fishing may involve chasing fish even across maritime borders as there may not be visible indicators of such borders and the fish swim underwater, out of sight. Similarly, since a reserve demarcated in the ocean realm, unlike one demarcated on land, may not have visible boundaries. Hence, trespass (human) may happen.

Thus, there are considerable differences between terrestrial and marine systems in terms of demarcating and monitoring borders. It is easier to fix boundaries of terrestrial systems and ensure their visibility by, for example, using fences and to monitor them by patrolling. In contrast, it is much more difficult to demarcate boundaries of marine ecosystems and make the boundaries visible. The costs of patrolling seas/oceans and enforcing regulations are higher than those for terrestrial ecosystems.

3.2.4 Key differences between terrestrial and marine ecosystems with re spect to environmental and ecological features and the patterns and consequences of human impacts (Source: Carr et.al 2003)

Feature	Terrestrial ecosystems	Marine ecosystems
Environmental		
Prevalence of aquatic medium	less	greater
Dimensions of species distribution	two-dimensional	three-dimensional
Scale of chemical and material transport	smaller	greater
''Openness'' of local environment (i.e., rates of import and export)	less	greater
Ecological		
Phyletic diversity (α and β)	less	greater
Life-history traits		
Per capita fecundity of invertebrates and small vertebrates	lower	higher
Per capita fecundity of mammals	low	low
Difference in dispersal between life stages	less	greater
Importance of pollination syndromes	great	minimal
Rate of response to environmental variability	lower	faster
Sensitivity to large-scale environmental variability	lower	higher
Population structure		
Spatial scale of propagule transport	smaller	greater
Spatial structure of populations	less open	more open
Reliance on external sources of recruitment	lower	higher
Likelihood of local self replenishment	high	low
Sensitivity to habitat fragmentation	greater	less
Sensitivity to smaller scale perturbations	greater	less
Temporal response to large-scale events	slower (centuries)	higher (decades)
Trophic		
Lateral transport of energy	low (few planktivores)	high (many planktivores)
Turnover of primary producers	slow (many perennials)	high (few perennials)
Reliance of carnivores on external input of prey	lower	higher
Prey populations influenced by external input of predators	lower	higher
Pronounced ontogenetic shifts of vertebrates	rare	very common
Genetic		
Effective population size	smaller	larger
Spatial scale of gene flow	smaller	larger
Interpopulation genetic diversity	higher	lower
Types and relative importance of contemporary human threats		
Habitat destruction	widespread	spatially focused (e.g., estuaries, coral reefs)
Loss of biogenic habitat structure	widespread (e.g., deforestation)	spatially focused (e.g., estuaries, coral reefs)
Trophic levels threatened or exploited	lower (primary producers)	higher (predators)
Degree of domestication	higher	lower

Concepts and theory for the design and application of terrestrial reserves is based on our understanding of environmental, ecological, and evolutionary processes responsible for biological diversity and sustainability of terrestrial ecosystems and how humans have influenced these processes.

How well this terrestrial-based theory can be applied toward the design and application of reserves in the coastal marine environment depends, in part, on the degree of similarity between these systems.

Differences exist between coastal marine and terrestrial ecosystems, in ecological and evolutionary processes.

These differences imply some unique design criteria and application of protected areas and other conservation strategies in the marine environment.

Main sources

- Lakshmi, A., Aurofilio Schiavina, Probir Banerjee, Ajit Reddy, Sunaina Mandeen, Sudarshan Rodriguez and Deepak Apte (2012). "The Challenged Coast of India", A report prepared by PondyCAN in collaboration with BNHS and TISS. October 2012. Available from http://deepakapte.com/attachments/article/20/Challenged%20Coast%20of%20India_Lowres.pdf
- Carr, M. H., Neigel, J. E., Estes, J. A., Andelman, S., Warner, R. R., and Largier, J. I. (2003). Comparing marine and terrestrial ecosystems: implications for the design of coastal marine reserves. Ecological applications, 13(1) supplement, 2003, pp. S90–s107
- Khera, N. (2013). Sustainable Management of Marine and Coastal Protected Areas: Taking an Inclusive Approach Technologies and their applications in sustainable use and conservation of coastal and marine protected areas in India. In Sivakumar, K. (Ed.) Coastal and Marine Protected Areas in India: Challenges and Way Forward, ENVIS Bulletin: Wildlife & Protected Areas. Vol. 15 Wildlife Institute of India, Dehradun-248001, India. 264-273 pp
- Millennium Ecosystem Assessment (MEA). 2005. Ecosystems and Human Well-being: Synthesis. Island Press, Washington, DC.
- Moberg, F, and Folke, C (1999), Ecological goods and services of coral reef ecosystems, Ecological Economics, Volume 29, Issue 2, May 1999, Pages 215-233, ISSN 0921-8009, http://doi.org/10.1016/S0921-8009(99)00009-9.
- NCSCM. 2012. Lagoons, Lives, Livelihoods. Editors: Purvaja Ramachandran, Ahana Lakshmi and Ramesh Ramachandran. Special publication for the 11th meeting of the Conference of Parties, Convention on Biological Diversity, Hyderabad, India. http://www.ncscm.res.in/cms/more/pdf/ncscmpublications/COP11%20BOOK%20Final.pdf
- NCSCM report/SAC. 2011. National Wetland Atlas. SAC/EPSA/ABHG/NWIA/ATLAS/34/2011. Space Applications Centre (ISRO), Ahmedabad, India, 310 pp.
- Parikh et al. (2012). The Economics of Ecosystems and Biodiversity-India. Initial Assessment and Scoping Report. Working Document. MoEF publication.
- UNEP Regional Seas Information Series. Technical Analysis for Policymakers on Issues

Related to Protection of the Marine and Coastal Environment. http://www.unep.org/regionalseas/publications/series/unep-rsp-info-series.pdf

- Venkatrama, K., (2005). Costal and marine biodiversity of India. Retrieved on 5th September, 2015 from http://nopr.niscair.res.in/bitstream/123456789/1544/1/IJMS%2034(1)%2057-75.pdf

Further resources

- Are there real differences among aquatic and terrestrial food webs? https://www.ncbi.nlm.nih.gov/pubmed/10998518
- Benjamin I. Ruttenberg and Elise F. Granek (2011). Bridging the marine–terrestrial disconnect to improve marine coastal zone science and management. MARINE ECOLOGY PROGRESS SERIES Mar Ecol Prog Ser. Vol. 434: 203–212, 2011 doi: 10.3354/meps09132 https://pdfs.semanticscholar.org/eac8/68ec7d34c95e840884aa230e2df6c0d845ed.pdf
- Coastal Zones of India. http://envfor.nic.in/sites/default/files/Coastal_Zones_of_India.pdf | SAC ISRo 2011
- The Structures and Adaptations to Marine Living - MarineBio.org. MarineBio Conservation Society. Web. Accessed 7:12 AM 10/2/2015. <http://marinebio.org/oceans/structures-adaptations/>
- R. Kearney, G. Farebrother, C.D. Buxton, Goodsell (2013) How terrestrial management concepts have led to unrealistic expectations of marine protected areas. Marine Policy 38 (2013) 304–311