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Abstract

Mangroves are one of the world's most productive ecosystems which are at present in it's threatened state. They provide a wide range of goods and services some of which have a direct value but more often provides many indirect benefits that seem to be hidden. The indiscriminate and exploitative nature towards extracting it's resources have led to severe loss in area throughout the world. In India, Mangroves were exploited indiscriminately during the 1960s.Traditionally considered as wastelands and dump yards, its importance were understood only over time. Hence, active conservation and regeneration activities were undertaken since the beginning of 1980s, yet the present area cover is only a modest remaining of the past. Such activities are undertaken by both the government in terms of legislative measures and active local community involvement. In addition, threats from Global Climate Change pose additional concerns for it's regeneration and restoration. The paper throws light on the status of mangrove cover in India, the benefits, threats and the existing policy framework .Existing legal and non-legal measures pose their own shortcomings and drawbacks in terms of lack of effective implementation of many such policies, lax of local communities towards continuous restoration activities, improper resources allocations between the two and thus lays the path for some measures that could in turn be adopted as lessons learnt from international case study examples.

Key words: *Mangroves, Conservation, Ecosystem services, Climate change and Policy*

JEL Codes : *Q220, Q250, Q260, Q500, Q570, Q580*

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INTRODUCTION

The Millennium Ecosystem Assessment defines Biodiversity or Biological diversity as "the variability among living organisms and the ecological complexes of which they are part". Diversity includes ecosystem diversity, species diversity and habitat diversity. It is important for our planet to be in good health and vitals which would ensure sustained life not just for the present but also for the future since we are mutually dependent on the ecosystem for goods and services and it turn depends on our care and use for it to remain a healthy ecosystem.

The four emerging trends that need to be paid attention globally, in view of the well being of our environment is the ever increasing population growth, decline of ecosystems that are vital to life, loss of biodiversity and some of the negative impacts of global Climate Change. Loss of biodiversity could be understood only if we understand it's importance. It provides an important source of food, fuel and fodder. It is essential for the economic growth and development of a nation, to protect the planet and ensure existence of it's species, not just of human life but also of the plants, animals and natural systems to reduce the negative risks of Climate Change. One of the major issues in studying an ecosystem and understanding it's importance is that it is often difficult to put a value to the benefits that the ecosystem provides as opposed to the cost of protecting it and most often, the importance of an ecosystem is understood in whole only when it is in it's threatened state.

Coastal ecosystems are one such ecosystems that provide high biological productivity and accessibility. It provides extensive goods and services. This has made them centers of human activity. The definition of coastal ecosystems is based on physical characteristics rather than their biological features. They host a motley array of habitats as compared to any other ecosystem. One such habitat, Mangroves is considered for the purpose of the study. Mangroves are shrubs, plants or trees that occur in intertidal areas. They occur in low oxygen soil wherein slow moving

water helps in the accumulation of fine sedements. Present only in tropical or subtropical areas, they provide a vast array of goods and services and facing it's own risks and pressures. The study aims to identify some of the economic benefits of Mangrove ecosystems, throw light upon the current state of mangroves in India covering the types of species present, area loss across five select major states over the years, the threats faced in relation to this. It also analyses the current policies intended for conservation and management by stating it's shortcomings and provides brief examples of International case studies that India could adopt to and learn from.

LITERATURE REVIEW

Kathiresan and Rajendran (2005) assess the status of mangroves along the Indian Ocean and throw light upon the area loss in each region, species present and the universal causes for disappearance of certain species. The find suggests that shrimp culture, wood chip and pulp industry and many other provisioning services provided by mangroves are the reasons for it's exploitation.

The paper Conservation and restoration of mangroves: Global status, perspectives, and prognosis by Romañach *et. al.* (2018) examines the threats to mangroves, it's consequences and potential solutions. The study proposes joint participation of local communities and the legislative framework for successful execution of conservation and restoration practices. The idea of Citizen Science is emphasized as a means to engage the local people and benefit from the knowledge they possess.

Datta *et. al.* (2012), examine the various community based mangrove management initiatives and report that South Asia implemented higher number of CBMM initiatives as compared to South America and Africa. It was found that transformation of knowledge of potential uses of mangroves that was specific to local communities to the

formalized institutions were found essential to ensure economic sustainability.

Das Gupta and Shaw (2013), in the paper examine the existing legal framework and identifies that it is against extinction threats. The paper also highlights that increased community participation is the way forward in resource management.

CURRENT ASSESSMENT OF MANGROVE AREA IN INDIA

Mangroves are trees or shrubs that occur in intertidal areas and are a part of tropical coastal ecosystems. The Total Mangrove covers in the world is 150,000 sq. km (World Atlas of Mangroves, 2010) and occur in 123 countries. South Asia comprises of 10,344 sq. km which is 6.8 percent of the world's mangrove cover. India's contribution is 45.8 percent of the total Mangrove cover in South Asia (Forest Survey of India, 2015).

In India, mangroves are present along the East Coast, West Coast and Andaman and Nicobar islands and are classified as Deltaic, Estuarine and Backwater, and Insular respectively according to Thom's classification of estuary habitats. The present cover of mangroves is 4921 sq.km (FSoI, 2015). There has been a very modest increase in the area cover from 1987(4,046 sq km) to present day . Nevertheless, the Indian mangroves have been significantly contributing to the total global area loss. Giri *et. al.* (2011) points out, the mangroves that once existed along the 7516.6 km long coastline of India has been constantly shrinking. Thus, the present cover is only a modest remaining of the past. Although, many legislative and non-legislative measures have been setup as early as the 1980s to conserve and regenerate them, this area loss could be attributed to the two decades immediately after independence when India was still largely engulfed in mass unemployment, poverty and underdevelopment. In this background, mangroves were treated as wastelands, dumping yards and were constantly exploited for some of

the benefits it provides. States such as Gujarat, Maharashtra, West Bengal and Odisha have shown increases in area cover over the years with Gujarat being the most remarkable of them all. In contrast, the mangroves in Andhra Pradesh and Andaman and Nicobar Islands have been consistently shrinking in size. It is essential to conserve them from further depletion or perhaps exploit them sustainably as all the mangroves in the world could be lost in the next 100 years if no measures are adopted to prevent area loss. Overall, India has always been in the forefront in Mangrove management. This is because of active efforts taken by the Ministry of Environment and Forestry and the Forest departments in conservation and regeneration activities.

ECOSYSTEM GOODS AND SERVICES

It is important to protect and conserve mangroves because they provide a number of valuable services, some of which are marketable and some non-marketable. Ecosystem goods and services are the benefits that are derived by humans from an ecosystem (Environment Protection Agency). They can be understood by categorising them as provisional, regulating, cultural and supporting.

Provisioning Services

They act as a provisioning service and provide a huge source of firewood, products derived from wood such as timber, poles and posts. In addition to this, they also provide non-wood sources such as wax, tannin, dye and plant materials for thatching and are a good substitute for fodder.

Regulating Services

These are benefits derived from the regulation of ecosystem processes. Since mangroves are present in intertidal zones, they act as a catalyst between the land and sea. This is a very unique phenomenon since water can engulf the land otherwise. They act as a shelter belt against cyclones, tsunami (In 2005 – villages surrounded by mangrove forests survived the impact of tsunami better than those which didn't (Kathiresan

and Rajendran, 2005) and prevents coastal erosion. They benefit not just humans, but also interact with other ecosystems such as coral reefs and form symbiotic relationships (mutualism) and prevent sedimentation and protect shorelines from devastative forces of wind, waves and driven debris. Furthermore, the distinctive morphology and physiology of mangroves lead them to act as natural flood barriers in their ecosystem.

Supporting Service

They provide a feeding, breeding and nursery ground for many commercially bred fish, prawn, crabs and molluscs. They also enhance nutrients and detritus of nearby coastal waters, therefore enhance the fishery production. A wide range of wildlife ranging from migratory birds to estuarine crocodiles and tigers are dependent on mangroves which act as a habitat.

Cultural Services

Any ecosystem has an innate ability to provide certain cultural services. They could be recreational, tourism or spiritual. One such spiritually bound species of mangroves in India are the Avicennia marina which represents the only sacred grove species of the world's inland mangroves (Sahu SC, *et. al.*). Such mangroves are communally protected and have significant religious insinuations for the community that protects it. Tourism is a very lucrative means of livelihood for the coastal communities that inhabit in and around mangroves. It is one of the highest revenue generators of coastal economies as it provides many varied jobs to the communities dependent on it.

Some of these services provided can also be classified as marketable and non-marketable. It is easy to attach a market value to the provisioning services derived out of mangroves and for that reason can also be denoted as marketable services. On the other hand, regulating and supporting services are more indirect in nature whose services are not traded in the market. Many of these services also possess characteristics of that of public goods, one person's benefits

cannot be solely excluded from receiving a service and one person's consumption also does not reduce the level of service received by another (eg. Prevention from natural disasters). The markets for such services are constrained and could be thought to represent, "market failure". The values of ecosystem services of mangroves are thus under supplied in the market.

THREATS

While mangrove forests do have specific functions that they play and provide a life support system and income for the people residing around forests, destruction also has become widespread for shorter economic benefits. Several natural and anthropogenic factors threaten mangrove ecosystems. The major threats to mangroves in India are due to:

Agriculture and Aquaculture

These activities are most prevalent and faced by States such as West Bengal and Tamil Nadu (Table 1). Large proportions of the land are cleared for agriculture expansion, the lands are made fertile using rainwater which reduces the salinity of the soil. Excessive amounts of fertilizers and pesticides are then sprayed which create spill over effects to surrounding ecosystems.

Exploitation of Mangroves for Provisioning Services

Mangrove wood is considered one of the best with high strength. They are suitable for industrial purposes. From Table 1, it can be seen that states such as Gujarat, Karnataka and Tamil Nadu face threats from over exploitation.

Natural Calamities

Mangroves act as a barrier against natural disasters but sometimes, disasters could in turn prove to affect mangroves. To cite a few examples are the case of 1999 cyclone which occurred in Odisha. It devastated a large area of mangroves and the trees were thus uprooted. Table 1

shows that Andaman and Nicobar islands have been constantly faced by loss in area due to calamities. The 2004 Tsunami caused extensive damage to mangroves along the south coast.

Pollution

Mangroves which are located in cities such as Mumbai and Kolkata face a huge risks from large amounts of solid waste and effluents that enter it's ecosystem. This makes it difficult for the mangroves to survive and hinders growth.

Threats from Unsustainable Tourism

This is a major threat faced by A and N islands (Table 1). It is one of the major reasons for area loss over the years. Tourism adds to the pressure of provisioning services and leads to greater extraction and exploration of the resources leads to greater exploitation. Conventional tourism in turn adds to the above threats mentioned and often puts pressure on local communities dependent on mangroves to compete for critical resources.

Climate Change

It is one of the most important issues that is universal in nature and cannot be attributed to just one state. Increase in temperatures, rise in sea levels, increasing frequencies of natural calamities are all repercussions of Global Climate change which in turn will have its own impact on mangroves. "A recent observation reveals that as a consequence of sea level rise two islands in Indian Sundarbans- Suparibhanga and Lohacharra have submerged and a dozen of other islands are also facing the same problem". (http://www.thedailystar.net/2006/12/22/ d61222011611.htm).

Further, the present area cover (FSoI, 2015) and threats faced by select five Indian states in relation to the dominant species have been tabulated below.

Table 1: State Wise Threats to Dominant Species

States	Dominant Species	Area In Sq. Km(2015)	Threats
West Bengal	S. Apetala, E. Agallocha and A. Alba	2016	Agriculture, Prawn Seed Collection, Freshwater Flow Reduction
Andaman And Nicobar Islands	Rizhophora, Bruguiera and Ceriops Forests	617	Calamities, Tourism Development Encroachment
Gujarat	Aviciennia Marina, Rizhopohora Mucronota	1107	Developmental Activities, Coral Reef Degradation
Tamil Nadu	Aviciennia Marina	47	Over Exploitation, Agriculture
Karnataka	R.Mucronota, A.Officinalis and S. Alba	3	Tree Felling, Pollution

Source: Tabulated Using Data From Forest Survey of India (2015) And Sahu e*t. al.* (2015).

EVOLUTION OF MANGROVE FOREST MANAGEMENT IN INDIA

Given that, mangroves provide many direct and indirect benefits to not just the human population, but also plants, animals and supporting ecosystem, there is a need to ensure it's sustainable use and improve it's management. In India, Forest management and Community have always played a very noteworthy part in the protection and conservation of mangroves. It dates all the way back to ancient India where a strong existence of local communities and individuals who were dependent on forest were institutionalized through numerous social and devout components such as sacred groves, sacrosanct and worship of certain trees. Knowledge resources of local communities were taken into account to ensure a forest's sustainable and prolonged use. The utilization of forests were overseen beneath a common property administration but it's possession and ownership was generally restricted to the administering rulers and the consent for exploitation of forest assets were generally granted by the king (Iftekhar, 2008). Natural forests were mainly

explored for the provisioning services it provided such as wood. In specific about mangroves, due it's geographical location in India, they were largely intact and was not subject to much exploitation.

In modern India, many legal and regulatory institutions have been set up for the protection of mangroves. For instance, the mangroves which are located near a notified forest area is covered under the Forest (conservation) Act, 1980. The forest Conservation Act theorized judicial use of resources where the National Forest policy of 1988 encouraged community participation in management, protection and regeneration. The need to ensure sustainable management in addition to conservation was realized between the period 1985-1990 and hence the National Conservation Strategy and Policy Statement on Environment and Development (1992), National Forest Policy and National Wildlife Action Plan highlights the importance of conservation and sustainable use of mangroves through various mechanisms.

CURRENT MANAGEMENT APPROACH

LEGISLATIVE

The current management of mangroves in India focus on a combination of legislative conservation as well as sustainable exploitation through cooperative management. (DasGupta, 2013). It was after the Ramsar Convention, which is a treaty for the conservation and sustainable use of wetlands that mangroves were under surveillance for steady restriction on it's deforestation. India formulated a comprehensive plan for the conservation of mangroves soon after the convention .There are also other committees such as the National Mangrove Committee which is an advisory body to promote scientific assessment and evaluation of mangrove habitats. In addition, realising the importance of marine ecosystems, especially of mangroves, the Government of India designated special Marine and Coastal Protected Areas. Marine ecosystems in Islands are considered as Category II (MoEF, GoI, 2008). The role of these areas is to preserve biodiversity, genetic diversity,

conserving and maintaining the ecological process. The other legislative initiative is through coastal zoning for effective management in order to restrict coastal urbanization through setting up of Coastal Regulation Zone. All the Indian mangroves receive legal protection under Environment Protection Act and are responsible for regulating activities that may affect mangrove ecosystems through the setting up of Environment Impact Assessment Notification.

Although, the data from the Forest Survey of India reveals that the overall trend of mangroves in India is not depleting, there is a need to protect the ecosystems simultaneously. Mangrove provides many indirect benefits as looked into earlier. Within the Indian setting, it has been demonstrated to play a preventive role in storm protection and risk reduction in times of natural disasters such as cyclones and tsunamis. As a result, revival of ecosystem services of mangroves is important for it's effective management.

In India, even though there are adequate legal supports for the conservation of mangroves, it lacks in terms of effective implementation. Many of the protected areas are often met with violation of the acts since more often they are met with poor staffing, inadequate man power and lack of facilities. This may be due to misdirection or inappropriate use of financial resources and lack of man power. The political climate and infrastructure of a country also play an important role in conservation and management. Climate Change has been talked about only very recently and there is as such very little framework to protect mangroves from anthropogenic activities and threats climate change and pollution.

NON- LEGISLATIVE

Considering that India is still a developing country, there are many literature evidences which support that many coastal population livelihoods are still dependent on the resources provided by mangroves. When resources from mangroves are extracted unsustainably, it can also be thought of as a benefit loss. One ecosystem service is always provided

at the cost of another and hence it is important to promote economic up-liftment of the mangrove dependent communities. The conservation of mangroves also do come at a cost, since many livelihoods are centered around the provisioning services provided by this ecosystem .Some mangroves are located in extremely dense and inaccessible areas and hence it's vigilance is difficult. In view of this, the Joint Mangrove Management, a cooperative approach has been implemented. Community based management now plays an important role in ensuring revival and conservation of this ecosystem by coming together with scientific bodies and the forest department.JMM is particularly prominent in states like Tamil Nadu, Orissa, West Bengal and Gujarat (Das Gupta, 2013).

In addition to community management, the role of NGOs also play a very prominent role in conservation such as Mangroves for the Future, Mangrove Society of India, WWF, MSSRF and many more. They often try to fill the gap of communication between the local communities and official departments. The presence of international NGOs also ensure funding, and offers scientific expertise, helps in conducting better awareness programmes. However, there are shortcomings even in the non-legislative setup since many of the community efforts are often misdirected to resource extraction as compared to effective conservation. Many fulfill their political interests and eventually the mass support for conservation and regeneration fades out. Communities often get bifurcated due to a very diverse caste and creed. Mangroves in a certain sense are thought of as public goods, and the access to such goods may be skewed if there are caste and creed issues among the local communities are often taught measures of revival and a forestation, they are also the ones that extract resources heavily.

MEASURES TO BE TAKEN

It is important to address some of the shortcomings of Legislative and Non-Legislative framework towards management, conservation, restoration and regeneration of mangroves.

- Economic valuations of the mangrove ecosystem goods and services can attract investments which will lead to even more effective management. The importance of an ecosystem is most often understood only when we no longer derive benefits from it, therefore effective cost-benefit analysis needs to be conducted since the provision of one ecosystem services comes at the cost of another and there are also many indirect benefits derived from such ecosystems that do not have a market value. There is no universal value to the mangrove ecosystems, since they widely vary based on socio-economic conditions from one region to another and hence careful analysis needs to be undertaken in specific to the Indian context. Such individual studies have been attempted in Matang Mangrove Forest Reserve in Malaysia where it is assessed that one hectare of mangroves contributes to ~US$37,500 per year to fisheries (Aburto-Oropeza *et. al.*, 2008).
- Population growth has evidenced to continue to rise around coastal areas. Their continued dependence on mangroves will lead to its exploitation rather than conservation. Active alternative livelihoods need to be provided to the communities if their activities continue to be exploited and deteriorate the health of mangroves. They could be effectively involved in eco-tourism. "Ecotourism is considered to be the cutting edge of creativity in the tourism industry". This would ensure that a large section of the community would be engaged in preserving and conservation activities, and the local communities could also sell some products which are derived in a sustainable manner. The case study of Iriomote Island in Japan has devised a successful model that promotes tourism and at the same time tour companies and tourists are educated to minimize the potential negative impacts to these ecosystems. This concept will offer a marketing tool to promote many services which are provided on the basis of sustainable principles and actively involve local communities.
- Improper benefit sharing between the governments and communities lead to conflicts and loss of community interest in

participatory management. More consistent funds need to be provided to communities for continuous management without any breaks. Community Stewardship in countries like Fiji and Samoa have led to considerable levels of protection.

- Marine and Coastal pollution are some of the biggest threats faced by the Indian mangroves. To prevent risks from disasters such as Tsunami, the government could mandate coastal barrier plantation such as countries like Indonesia and Malaysia.
- Management of mangroves in India has been a combination of Community participation coupled with legal framework. The involvement of private sector to increase stakeholder participation in it's conservation programmes could be explored. Such an example is the case of "Global Conservation Standard" in Costa Rica which is a financial mechanism by which the private sector companies could buy conservation credits and for every revenue it generates, it could in turn use a part or whole to invest in sustainable development activities of ecosystem goods and services.

The paper reviews not only the current status of mangroves in India, but also some of the direct and indirect benefits that are provided by them. Citations of certain international case studies provide insights into what could further be enhanced in India for better management. In addition, the threats faced by mangrove ecosystems in India highlights the importance of coastal and marine ecosystems. Conservation needs to be linked with a broader perspective with active community involvement, environmental security and reducing any risks from natural calamities. Such measures need to be adopted more holistically in view of anticipatory adaptation measures which hold the clue for a successful and effective management.

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