MANGROVES IN CLIMATE CHANGE BASED DISASTER RISK REDUCTION: SOME CONSIDERATIONS

By

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1. Rationale

In Asia, the 2004 tsunami would have been less disastrous if the mangroves, serving as a natural barrier, had not been destroyed for tourism and shrimp farming; in the Northern Pakistan earth quake, local people claim that intact forest cover prevented landslides which caused extensive damage elsewhere.

More and more natural hazards such as hurricanes, earthquakes, droughts or floods are taking an increasing toll on human lives, infrastructure, and the global economy. While they cannot be controlled, natural hazards do not need to trigger a disaster. Their impact can be much reduced by leaving nature's protective infrastructure firmly in place – such as dunes, mangroves, coral reefs, forests on steep slopes. Even better, this 'insurance policy' is not only free, but comes with an immediate bonus: mangroves for instance are natural fish nurseries, supporting the livelihoods of poor fisher folk along the coast.

Ecosystems also come into play in the reconstruction phase after a storm, earthquake, flood or drought has provoked a human disaster: Disposal of debris in wetlands can cause a decrease in fish stocks and freshwater supply. Local people in many countries depend on forest for their livelihoods: they provide meat, firewood, fruits, honey, medicinal plants and fibre such as rattan or palm leafs for housing material. However, these are often no longer available to them as the forests had been cleared before or during the reconstruction effort.

Despite their valuable services, ecosystems are hardly taken into account in land allocation, disaster preparedness, or the relief and reconstruction phase following a disaster. It is therefore essential to understand role of mangroves with regard to livelihood security.

2. Mangroves and livelihood security

Mangrove ecosystems support a large variety of wildlife, both flora and fauna. Various forms of anthropogenic pressures threaten these natural resources in Gujarat, Maharashtra and Goa, as in the other States of India. The extent of loss may vary depending on factors such as the following:

- accessibility of the resource,
- purpose behind the use of resource,
- method of collecting the resource,
- conveyance and transport,

- number of people using the resource, and
- availability of other natural resource.

A lack of understanding of the value and significance of mangrove forests, with reference to their roles in sustaining the environmental support system of coastal areas, the maintenance of coastal biodiversity and the livelihood security of coastal communities, are all leading to the destruction of these natural resources. A great challenge therefore lies in the protection of these unique ecosystems while safeguarding the livelihood security of coastal people.

3. Approaches to reducing Disaster Risk along the coastal regions

3.1. Reducing Disaster Risk: People oriented large scale mangrove plantations

Various people-centred activities can be proposed for undertaking "Pre-storation" activity (undertaking large scale plantations in un-disturbed but critical coastal regions that would minimize impact of possible Disaster in due course) OR afforestation of mangrove species in their habitats, which would deal with

- Identification of degraded mangrove areas;
- Identification of human and nature induced stresses on mangrove ecosystems;
- Establishment of nurseries of mangrove propagules in various coastal areas of Gujarat, Maharashtra and Goa with the help of State Forest Department and local people;
- Development of methodology for restoring degraded mangrove areas;
- Conducting large scale plantations with the help of local people; and
- Create awareness among local people to secure their participation in conservation efforts.

Table 1: Conservation management policies for critical mangrove forest areas, classified by habitat and community type.

Category	**Management Priorities**
Primary/ pristine mangroves	Regardless of location, to be preserved as reserves (after looking at genetic variability within the forest)/ Mangrove Genetic Resources Conservation Centres (MGRCCs).
Mangroves subjected to significant environmental hazards	A minimum protective zone of mangrove forest should be left untouched, e.g., (a) about 100 m on open coast; (b) about 25 m on river banks and lagoons; and (c) about 10 m on inland banks, creeks and channels
Mangrove areas near/ adjacent to known habitats as fishing grounds	Such areas should not be alienated or released for development.
Mangrove areas near urban centres/ populated areas	To be conserved for (a) sustainable utilisation; (b) tourism; (c) coastal protection; (d) education; and (e) recreation for local people, who could be involved in their maintenance, restoration, etc.

Category	Management Priorities
Mangroves on small islands	They form a major ecological component of island ecosystem and hence not to be disturbed at all.
Mangroves in estuarine areas	Mangroves on the river-banks as well as mouth to be preserved to maintain ecological balance of estuarine areas.
Areas with abundant mature Mangrove “Mother Trees”	Such areas to be preserved for posterity.

Lewis and Marshall (1997) have suggested five critical steps that are necessary to achieve successful mangrove restoration:

1. Understand the autecology (individual species ecology) of the mangrove species at the site, in particular the patterns of reproduction, propagule distribution and successful seedling establishment.
2. Understand the normal hydrologic patterns that control the distribution and successful establishment and growth of targeted mangrove species.
3. Assess the modifications of the previous mangrove environment that occurred that currently prevents natural secondary succession.
4. Design the restoration program to initially restore the appropriate hydrology and utilize natural volunteer mangrove propagule recruitment for plant establishment.
5. Only utilize actual planting of propagules, collected seedlings or cultivated seedlings after determining through Steps 1–4 that natural recruitment will not provide the quantity of successfully established seedlings, rate of stabilization or rate of growth of saplings established as goals for the restoration project.

The ecology of the mangrove wetlands is influenced by a number of macro-level physical forces. Among them, the quantity and periodicity of freshwater flow plays a significant role in determining the species diversity, biomass and forest structure. This is especially important for river-dominated mangrove wetlands since the flora of these mangrove wetlands is more susceptible to reduction in freshwater flow than tide-dominated mangrove wetlands. Secondly, species selection for plantation or restoration of degraded mangroves needs to be based on the currently available species. Any attempt to reintroduce the low-saline species that were lost from a mangrove wetland might not succeed without increasing the freshwater flow. Thirdly, river-dominated mangroves characterized by high nutrient influx and strong out-welling from mangrove forests, play a significant role in maintaining the fishery production of the adjacent coastal waters4. Hence, reduction in freshwater flow would affect the amount of nutrient exported to coastal environment and thereby affect fishery production.

3.1.1. Large scale mangrove restoration techniques

Mangrove habitat around the world can self-repair or successfully undergo secondary succession in 15-30 years if:

- the normal tidal hydrology is not disrupted, and
- the availability of waterborne seeds or seedlings (propagules) of mangroves from adjacent stands is not disrupted or blocked.

If normal or near-normal tidal hydrology exists but waterborne seeds or seedlings (propagules) cannot reach the restoration site, mangroves can be successfully established by planting.

Because mangrove habitat can recover without planting, restoration planning should first look at the potential existence of blocked tidal flow or other environmental stresses that may prevent mangrove recruitment. If blocked tidal flows or other stresses are present, they should be removed. If they are not present, or after they have been removed, observations to determine if natural seedling recruitment is occurring should be undertaken. Assisting natural recovery through planting should only be considered if natural recruitment is not occurring.

Unfortunately, many mangrove restoration projects move immediately into planting of mangroves without determining why natural recovery has not occurred. All too often, capital is invested to grow mangrove seedlings in a nursery and to plant restoration sites before stress factors are assessed and, if necessary, removed. This often results in major failures of planting efforts. For example, Sanyal (1998) reported 1.52 percent survival rates of mangroves planted in West Bengal, India. On the other hand, natural recruitment may lead to substantial mangrove tree densities provided that environmental stresses have been removed. For example, Duke (1996) reported that "…densities of natural recruits far exceeded both expected and observed densities of planted seedlings in both sheltered and exposed sites" (emphasis added) for a site in Panama, and Soemodihardjo et al. (1996) reported that only 10 percent of a logged area in Tembilahan, Indonesia, needed replanting because "The rest of the logged over area…had more than 2,500 natural seedlings per ha" (emphasis added).

Ecological restoration of mangrove habitat is feasible, has been done on a large scale in various parts of the world, and can be done cost-effectively. The simple application of the five steps to successful mangrove restoration described here would at least ensure an analytical thought process and less use of "gardening" of mangroves as the solution to all mangrove restoration problems. At appropriate sites with normal or near-normal tidal hydrology and with establishment of mangroves through natural recruitment or planting, restored mangrove systems can become indistinguishable from nearby natural mangrove systems within a short time. Dense thickets of mangrove shrubs can develop within 5 years of plant establishment. In most of the tropical regions, forests with trees taller than 5 m, with well-established prop root and pneumatophore networks, and with closed canopies can develop within 15 years.

3.2. Sustainable Management of Mangrove Ecosystems: Some Perceptions

With a view to tackle the issue of Disaster Risk Reduction in coastal regions, it is imperative to adopt "Sustainable Management Approach" in case of mangroves, with an objective to:

- arrest the recent and rapid destruction of mangrove ecosystems, to improve their management, and to conserve biodiversity in these critical natural habitats, AND

- provide a tool for effective management of mangrove ecosystems for State/ Central Governments, resource managers, NGOs, traditional authorities and communities, donors and development agencies, and conservation groups

To achieve the above objectives, a set of 15 perceptions are defined and are highlighted on the following pages:

3.2.1. Perception 1: Mangrove Management Objectives

The fundamental objective to mangrove management is to promote conservation, rehabilitation and sustainable utilisation of mangrove ecosystems to benefit the global population.

States and Stakeholders could achieve these objectives by:

- Taking precautionary approach to mangrove management;
- Adopting ecosystem approach to mangrove conservation;
- Identifying and protecting biodiversity hot spots
- Recognising and protecting the special needs of indigenous communities;
- Mitigating adverse ecological impacts due to anthropogenic pressures;
- Rehabilitating/ restoring/ "prestoring" degraded/ destroyed mangrove areas.

Mangrove Management: Logical Framework Approach

Development Objectives: Conservation:

- Directly protect pristine mangrove areas
- Protect mangroves from destruction, degradation and other significant human impacts
- Promote natural regeneration where mangrove ecosystems have the capacity for self-renewal
- Rehabilitate degraded mangrove ecosystems
- Protect and enforce mangrove buffer zones
- Protect and enhance cultural and social values
- Promote and improve sustainable traditional management techniques
- Support co-management with local communities

Mangrove Management: Logical Framework Approach

Immediate Objectives: Policy:

- Improve and reform Governance Structures for management and conservation
- Adopt policy reforms for sustainable management and conservation (from research and experience)
- Strengthen and harmonise regulations enabling the sustainable harvest of mangrove resources
- Restructure property right regimes to protect mangrove resources and ecosystems

- Promote use of economic incentives by governments and the private sector
- Disseminate information for better policy decisions
- Empower local people and promote participation in management of coastal resources
- Safeguard the use of traditional knowledge
- Promote research on mangrove ecosystems, species and genetics

Mangrove Management: Logical Framework Approach

Immediate Objectives: People:

- Increase livelihood opportunities
- Strengthen capacity of stakeholders
- Identify and resolve ownership issues
- Promote sustainability of livelihoods
- Provide Communication, Education, and Public Awareness support
- Be sensitive to equity and gender issues
- Promote fair trade of mangrove products

Mangrove Management: Logical Framework Approach

Immediate Objectives: Productivity:

- Identify and improve the use of best management practices for mangrove ecosystems through research, education and incentives for compliance by resource users
- Increase productivity from mangrove resources for commercial use, while protecting the livelihood of sustainable users
- Identify and promote alternative sustainable uses of the resources

3.2.2. Perception 2: Precautionary Approach to Management

A decision to take action based on the possibility of significant environmental damage, even before there is conclusive, scientific evidence, that the damage will occur (E.C. 1999).

The overall approach to mangrove management should be a precautionary one, but a lack of scientific information should not be an argument for postponing, or failing to implement mangrove conservation and sustainable management measures.

Examples of endangered mangrove-associated animal species

- The Sunderbans Tiger, India and Bangladesh (endangered)
- Proboscis Monkey, Borneo (endangered)
- Manatees & Dugongs in tropical regions (vulnerable)

Examples of Alien/ Exotic Species

- *Nypa fruticans* (introduced from Singapore to Nigeria); displaced *Rhizophora* and *Raphia*, an important palm.
- Tiliapias (introduced from Africa to Asia) form extensive areas in brackish water habitats.
- Skin Gourami (introduced from Africa to Columbia for cage fishery); escaped from cages and replaced river fish.

3.2.3. Perception 3: Legal Framework

We need both, national and international legal frameworks to provide us with overall guidance for the conservation and sustainable use of mangrove resources and to ensure protection for mangrove-associated biodiversity.

Examples of the legal framework

- Policy [Thailand (to increase mangrove cover from 1,70 lakh to 2.00 lakh ha)];
- Regulations [Philippines (existing Law to prohibit cutting); Brazil (prohibition since 1926, except for public utilities, etc.); India (Maharashtra, prohibition under the Felling of Trees Act, 1987)]

Examples of land use zoning involving mangroves:

- Zoning Plan [Core (for strict protection); buffer (for sustainable development) and transition (for multiple use)] available; e.g., Vietnam, Ecuador, Senegal, etc.

Examples of measures to promote compliance:

- Cambodia (illegal charcoal kilns in WL Sanctuary); Ecuador (fine for cutting mangroves); Kenya (license for cutting needed)

Examples of Community Self-regulation: Concept of Sacred Forests:

- Ghana (coastal forests abode of Gods, utilised); India (concept of sacred groves exists, owned by temple trusts apart from Revenue/ Forest Dept.)

Examples of Forest or Trust Funds used to support conservation:

- Malaysia (Forest Development Fund established by Forest Dept.); Philippines (forests leased to communities on JFM concept); Nigeria (Ecological Trust Funds generated as 1 % of the revenue from Oil).

3.2.4. Perception 4: Implementation

There is general weakness in implementation of legal framework for mangroves and lack of consultation between the management agencies and the various mangrove stakeholders.

Examples of indirect activities that affect mangroves:

- India [(diversion of water and sediments in Ganges River since 1974; Reduction of influx of freshwater from upstream regions due to drought – Pichavaram, Tamil Nadu]; Ghana [damming of rivers leading to reduction of mangrove cover]; Brazil [damming caused reduction of sediment deposits along the estuary].

Examples of National Coordinating Bodies of Mangroves:

- India including South and South-east Asia (NATMANCOMs established);
- State level Committees, NGOs encouraged to conservation and development in India

3.2.5. Perception 5: Mangrove Inventory for Management

Mangrove surveys, inventory and monitoring data are required to support sustainable management.

Examples of use of Remote Sensing

- Thailand (forest data base developed for visualising potential)

Examples of mangrove data bases

- MEIS (MSSRF), GLOMIS (ISME)

Guidelines for Mangrove Survey and Inventory:

Biophysical Features:

- Location, Area and Demarcation
- Climate
- Tidal/ Hydrological regime
- Dominant Soil Type (colour, organic matter, texture)
- Water Chemistry (salinity, pH, nutrients, colour)
- Type of Forest (primary, secondary, degraded)
- Structure of the Forest (density, height of trees, basal area, IVI)
- Species inventories (flora and fauna)

Management Features:

- Existing or proposed land zoning system
- Land/ water use and ownership
- Local knowledge/ traditional uses
- Ecosystem products, functions and attributes

- Pressures and threats on the area
- Potential areas available for rehabilitation/ restoration.

3.2.6. Perception 6: Socio-economic Considerations

Mangroves provide important socio-economic benefits to poor coastal communities worldwide and the sustainable management of mangrove resources is necessary to maintain and improve their livelihoods.

Examples of protection systems used in mangrove ecosystems

- India (Tamil Nadu – communities use mangrove areas for crab production); Vietnam & the Philippines (communities paid to plant mangroves)

Examples of mangrove plantations for fodder/ fuel wood provision

- India (Sunderbans – *Acacia auriculiformis* planted for reduction of anthropogenic pressure on mangroves);
- Pakistan, Egypt (plantations raised for supply of leaves as fodder for goats, camel, cattle).

Examples of regulation to control pollution

- Thailand (environmental regulation on shrimp farming); Nigeria (regulation on effluent discharge/ pollution levels in the coastal regions); Colombia (restriction on activities that lead to pollution in the coastal regions.

3.2.7. Perception 7: Cultural and Community Issues

Mangrove ecosystems are under severe pressure from some traditional and non-traditional forms of exploitation even though in many countries, they are associated with unique human traditions and knowledge.

Examples of important cultural/ historical associations with mangroves

- Thailand (Sea Gypsies in Ranong live without Govt. recognition);
- Vietnam (Can Gio Biosphere Reserve planted by People after 1978 War);
- India (Tamil Nadu – Thillai Vanam at Chidambaram; Sunderbans, W. Bengal – Banobibi/ Vanodevi Concept);
- West and East Africa (mangroves as fuel for salt production).

Examples of value and traditional knowledge of mangroves

- South and Southeast Asia (mangroves as medicines);
- Nigeria (dyeing of fishing nets to prevent crab attack);
- Ecuador (liquor from pneumatophores of *Avicennia*).

Examples of improved livelihood options

- Vietnam, India (people employed to protect mangroves);
- Combodia (People provided alternate livelihood options).

Examples of contribution of Women in mangrove management

- India (Women become members of Forest Protection Committee);
- Ghana (women encouraged in mangrove plantations)
- Senegal, India (women involved in oyster extraction/ cultivation).

Examples of inter-community cooperation for mangrove rehabilitation

- Vietnam, Philippines, Guinea, Senegal, Ecuador (Community Leaders representing different communities are involved in monitoring management and rehabilitation programmes funded by international Donors).

3.2.8. Perception 8: Capacity Building / Development

Capacity Development for mangrove management and awareness raising about mangroves is needed at all levels from decision makers in government, to community leaders and educational institutions (teachers, students and school children).

Examples of existing educational programme on mangroves

- India (All the maritime States have taken lead in mangrove awareness generation activities); Ghana, Thailand, Vietnam, Bangladesh, Nigeria, Senegal, Ecuador follow the system at formal levels of education.

Examples of community training in mangrove resource management

- Senegal, Nigeria, Philippines, Thailand, Vietnam are leaders in this activity.

Examples of regional and international training opportunities on mangroves

- India (NIO, MSSRF, CAS in Marine Biology) offers international training in mangrove management/ biodiversity/ rehabilitation, etc.
- Ghana (Centre for African Wetlands) takes care of legal issues, policy framework, etc.
- APEC (Asia Pacific Economic Cooperation) offers training to teachers.

Examples of information centres/ information dissemination centres for mangroves

- India (Nagla, Vikhroli – Maharashtra); Thailand (Ranong); Senegal (Saloum Biosphere Reserve), Brazil (Labomar Institute) provide such centres.

- Information dissemination centres operational in Vietnam (lower Mekong Delta region) and Ecuador (policies are decided by the Govt. after receiving information on mangroves from local stakeholders/ Universities).

3.2.9. Perception 9: Forestry/ Silviculture Management

Mangrove Forestry/ silviculture objectives may have an economic, environmental or aesthetic basis, or a combination of these. The specific objectives for forest management include timber and fuel wood production, shoreline and river channel stabilisation, landfill and waste management, fisheries and wildlife support, storm and flood protection, ecological and biodiversity restoration and land-scaping.

Examples of converted/ destroyed mangroves

- India (Mumbai and many maritime towns, villages, for want of housing); Ecuador, Brazil, Venezuela, (abandoned shrimp farms, salt pans, silviculture areas).

Examples of strongly impacted/ degraded mangroves

- Oil impacted mangroves (Malaysia, Panama, Venezuela, Brazil);
- Industrial areas (Brazil, Colombia).

Examples of mangrove forest management

- Wood production (Malaysia, Vietnam); Coastal Protection (India, Bangladesh, South-east Asia);
- Biodiversity Conservation (India, Vietnam – multiple species planting);
- Rehabilitation of degraded mangroves (Kenya, India, Thailand, Philippines)
- Shrimp ponds and tin mining areas.

3.2.10. Perception 10: Fisheries and Aquaculture

Mangrove associated fisheries and aquaculture have worldwide importance in providing subsistence food and income, as well as commercial benefits, for a wide range of stakeholders, from very poor fisher communities and coastal farmers, to major companies that have invested in aquaculture and seafood processing. Thus, the importance of effective management in relation to mangrove fisheries and aquaculture development cannot be overestimated.

Unsustainable fishing is also caused by lack of enforcement of existing fisheries regulations to protect major mangrove nursery sits. This along with lack of enforcement of environmental regulations also lead to various problems in management of mangroves.

Examples

- Mangrove habitat protection to conserve fishery stocks (Brazil, Vietnam);
- Destructive fishing methods (The Philippines);

- Better management practices (Senegal, West Africa).

3.2.11. Perception 11: Agriculture, salt production and mining

Mangrove conversion to other forms of land use, including agriculture, mining activities and salt pans is a major cause of wetland habitat damage in various Countries. In Africa and parts of Asia, mining is fairly common in coastal areas.

Examples of damage to mangroves due to agriculture:

- Mangrove habitat degradation (India – Maharashtra);
- Ghana (sand mining);
- Thailand (tin mining).

3.2.12. Perception 12: Tourism, Research and Education

Tourism is the world's largest and fastest growing sector of the global economy. Mangroves provide many potential opportunities for eco-tourism, including fishing, bird watching, viewing wildlife and scenic boat rides.

Examples of management issues affecting tourism sites involving mangroves

- India (Mahim Nature Park, Mumbai, Borivli National Park, Mumbai);
- Malaysia (Selangor Nature Park); Kenya (Wasini island).

3.2.13. Perception 13: Mangrove Products and Responsible Trade

Sustainably produced mangrove products should be promoted by the Govt. for benefit sharing.

Examples of research on the sustainable use of mangrove products

- India (crab/ oyster/ shrimp farming in mangrove areas – Maharashtra, Orissa, Andhra Pradesh, Karnataka, Goa);
- Vietnam (farming of mudskippers involving poor farmers);
- Brazil (Oyster rearing).

Examples of the potential to promote "green labelling"

- Matang Mangrove Forest produces charcoal, which is exported to Japan (with a tag as a "product from sustainably managed forest"

3.2.14. Perception 14: Mangrove Research and Information Exchange

Poor understanding of the functions and values of mangrove ecosystems continues to hamper efforts to conserve and manage mangrove resources sustainably. However, there are considerable skills,

information and opportunities worldwide to use research knowledge more effectively to improve management.

Examples

- Multidisciplinary research on mangroves
- Current exchange mechanism for information on mangroves (data bases, e-mail discussion groups)
- Recent taxonomic research on mangrove species
- Mangrove Genetic Resources Centres (MGRCCs)
- Application of economic valuation of mangroves (marketed/ non/marketed; on-site/ off-site)
- Mangrove traditional knowledge (documentation)
- Mangrove Rehabilitation Guidelines (Govt. of India).

3.2.15. Perception 15: Integration of mangrove management in to coastal zone and river basin management

Mangrove ecosystem management is an integral part of the coastal zone and river basin area management. Strong coordination is required at all levels between the authorities concerned with mangroves and other coastal and riverine ecosystems and resources.

Examples

- Regional cooperation mechanisms
- Inter-ministerial Committees for implementation of national policies affecting mangroves
- Mangroves used for disaster preparedness.

4. Way ahead

When dealing with climate change risks it is important to recognize that the starting point

for adaptation measures is the existing vulnerability to climate variability and extremes. Improving the capacity of communities, governments or regions to deal with current climate vulnerabilities is likely improving also their capacity to deal with future climatic changes, in particular if such measures take a dynamic approach and consequently can be adjusted to further changes in risks and vulnerabilities. To promote an integrated approach to disaster risk management it is necessary to:

- Identify and appreciate the information, experience and methodologies that disaster risk, climate change and development experts can provide and design a system to share such experience and knowledge, AND
- Overcome some institutional barriers (structural, managerial, information, financial) to facilitate the integration of experience, information and knowledge of development, climate change and disaster risk management experts.

References:

1. Deshmukh, S.V. and V. Balaji (Eds.) (1994). *Conservation and Management of Mangrove Forest Genetic Resources*: *A Training Manual*. CRSARD, M.S. Swaminathan Research Foundation, Chennai, India. 487p.

2. Lewis, R. R., and M.J. Marshall, M.J. 1997. *Principles of successful restoration of shrimp Aquaculture ponds back to mangrove forests*. Programa/ resumes de Marcuba '97, September 15/20, Palacio de Convenciones de La Habana, Cuba. 126p.

3. Swaminathan, M.S., and Sanjay Deshmukh (Eds.) (1995). *Genetic Engineering and Adaptation to Climatic Changes: Establishment of Genetic Resources Centre for Identifying and Conserving Candidate Genes for use in the Development of Transgenic Plants*. Final Report of the DBT-CRSARD Project, M.S. Swaminathan Research Foundation, Chennai, India. 523p.