

Policy Brief: Bioshields

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THE DECEMBER 2004 TSUNAMI caused considerable damage in many countries in south and southeast Asia. Subsequent actions with regard to disaster management and rehabilitation have involved large-scale expenditure of effort and funds both by governments and non-governmental organisations (NGOs). Despite the twenty-first century homilies about the importance of science, its role in influencing policy and environmental decision-making is far from clear.

Following the tsunami, there was particular interest globally in activities concerning ‘bioshields’ or ‘coastal shelterbelts’, which are coastal vegetation structures (both natural and planted) that are expected to protect the coast from storms, cyclones and even tsunamis to a varying extent. Large amounts of funds have been spent in planting these along the coast in India and in other countries, with potentially significant social and ecological impacts in coastal areas (Mukherjee *et al.* 2007). In this policy note, we review the science with regard to bioshields and examine its role in policy and implementation along the mainland coast of India. It is crucial at this juncture to take stock and analyse the implications of promoting bioshields at such massive scales from an impartial multiple stakeholder perspective.

The History of Coastal Plantations

Activities related to bioshields creation in India are not recent, though they have become popular after the 2004 tsunami. The term ‘bioshields’ itself has only entered the lexicon recently. Forest Department records bear testimony to the fact that bioshields have been raised under various schemes since the late 1960s, if not even earlier.

There is documented evidence of *Casuarina* sp. plantations being raised by the Tamil Nadu Forest Department from the early 1960s. In Andhra Pradesh, a ‘super cyclone’ in 1977 propelled the central and state governments (in collaboration with the World Bank) into promoting plantations as coastal protection measures. Subsequently, with every major cyclone or storm event, there has been a surge of efforts towards establishing bioshields along the coast.

The trend towards plantations continues within the departments of Andhra Pradesh and Tamil Nadu, although at a much grander scale now, owing to generous international funding towards post-tsunami impact mitigation and prevention.

Did 'Bioshields' Protect the Coast?

In scientific circles there seems to be a dichotomous view concerning bioshields, with some authors strongly in favour and others equally strongly against it. In fact, there is no consensus on whether these plantations played a protective role during the December 2004 tsunami. To begin with, in 2005, Kathiresan and Rajendran of the Centre of Advanced Study in Marine Biology, Annamalai University, Tamil Nadu, carried out a study in 18 tsunami affected hamlets in Tamil Nadu, showing that the hamlets located behind mangroves and other coastal vegetation suffered less human death and damages (Kathiresan & Rajendran 2005). Following this, Danielsen and a large international group of authors published a paper in the prestigious journal, *Science*, arguing the protective role of coastal vegetation. They also pointed out that in Cuddalore district, Tamil Nadu, the impact of the tsunami was significantly lesser in villages protected by mangroves and casuarina than in others (Danielsen *et al.* 2005). Others investigated the protective role of bioshields by comparing pre-tsunami and post-tsunami satellite images and concluded that coastal vegetation structures like mangroves and coastal shelterbelts had provided protection from the tsunami (Olwig *et al.* 2007).

Subsequently, however, several studies criticised these findings as being simplistic, incomplete and over-eager in interpretation. These studies indicated that the impact of the tsunami was highly dependent on topography (and bathymetry), distance from the shore, and other physical factors, and that vegetation contributed little, if any, protection to the coast (Dahdouh-Guebas *et al.* 2006; Vermaat & Thampanya 2006; Wolanski 2007).

Furthermore, natural vegetation such as mangroves may have chosen physically protected environments to grow in, thus making it appear that they had provided protection. Most important, the vulnerability of the coast to such events may be highly influenced by coastal development, a factor not considered at all. In a review of the effect of coastal defences in the face of the tsunami, it was suggested that sea-grasses may have attenuated the effect of the tsunami, while coral reefs may have actually exacerbated it; there is, however, little conclusive evidence what role, if any, coastal vegetation played in protecting the coast (Chatenoux & Peduzzi 2007).

A re-analysis of the data from Tamil Nadu concluded that mangroves and other vegetation did not have a significant effect on the impact of the tsunami; instead, topography and distance from the shoreline were stated as major factors determining the impact of the tsunami (Kerr *et al.* 2006). In a paper in *Current Science*, field-based mapping and remote sensing analysis was used to show that there was no significant correlation between vegetation cover and inundation caused by the tsunami (Bhalla 2007). The author also mentioned the detrimental impact of growing exotic trees like *Casuarina* on natural sand dunes.

However, many of these studies only looked at the protection value of coastal vegetation. Other authors have given a detailed account of the value of mangroves as bioshields, arguing that coastal forests including mangroves need to be restored urgently for shoreline protection as well as for eco-hydrological services. Mascarenhas and Jayakumar (2007) emphasised the importance of sand dunes in shoreline protection and concluded by highlighting the significance of the Coastal





Regulation Zone (CRZ) policy. Others pointed out the need for bioshields within the framework of Integrated Coastal Zone Management (Sonak *et al.* 2008).

In a classic review on mangrove forests covering aspects of resilience, protection from tsunamis and vulnerability to climate change, Alongi (2008) points out that mangroves may offer limited protection from tsunamis; some models have suggested marked reduction in tsunami wave flow pressure for forests that are at least 100 m in width. He also draws attention to the fact that the magnitude of energy absorption is determined by several biological and geological factors like tree density, stem and root diameter, shore slope, bathymetry, spectral characteristics of incident waves and tidal stage.

In summary, the scientific literature shows no clear consensus about the effectiveness of bioshields, particularly casuarina, in coastal protection and tsunami mitigation.

‘Bioshields’ Behind and Beside Villages

As part of an ongoing study and survey undertaken by the Ashoka Trust for Research in Ecology and the Environment, of the 20 odd villages surveyed in Kariakal and Nagapattinam districts, only two villages actually had ‘bioshields’, i.e., casuarina plantations, in front of the village. These happened to be small villages with very few active fishermen and boats. The rest of the ‘bioshields’ are being planted in locations that might be adjacent to the villages or behind them. This does not really meet their description as ‘bioshields’ and are merely coastal plantations. Coastal protection and disaster mitigation are the main benefits and indeed the very justification of these externally funded plantation programmes. Experts are in fact of the view that casuarina or any plantation on either side of fishing hamlets makes these

settlements more vulnerable to natural events, such as cyclones, since wind is then funnelled/channelled into the hamlet with plantations on either side blocking the path of the wind.

What Plantations Do Communities Want?

There have been exercises that have studied and documented community preferences of plant species both within the housing settlement as well as on community land as green belts. An excellent example of promotion of local species and localised planning is seen in the initiatives undertaken by Architecture and Development in some hamlets in Karaikal district where local Participatory Rural Appraisal (PRA) tools were used for developing lists of local species in the area. A survey was also conducted to document the preference for these various species and their uses by the community. A nursery was developed to propagate and promote these species, both in existing villages as well as the new housing site, in addition to a green belt on common land.

Socio-ecological Aspects

The model currently being followed in the implementation of the World Bank’s shelterbelt programme is a mixture of the joint forest management (JFM) and social forestry programmes of the Forest Department. The Forest Department in each hamlet does a PRA based on which a village level micro-plan is made and Village Forest Committees (VFCs) are formed. This does lay some partial emphasis on process and participation, but the ground reality, the quality of process and participation is not known. As part of the programme, a number of entry point activities are executed. These are basically to build the trust of the community and get their cooperation. However, unlike other areas, coastal communities are



unfamiliar with exercises and programmes such as JFM, social forestry and village micro-plans.

There has been very little focus on the social and legal aspects of shelterbelts in the coastal areas of the country. However, in the past there have been cases of conflicts between the Forest Department (who promoted and implemented afforestation projects) and local communities on issues of access, passage and rights. The communities are aware of these cases (they have narrated instances in other areas/hamlets where conflicts have occurred), and hence their perception has not been positive, making them wary of plantations/restoration projects. In some villages, the communities have admitted to removing saplings being planted (Rodriguez 2007).

The Forest Departments have mostly sub-contracted the PRA exercise to local NGOs. A closer look at the PRA format reveals that it is only a survey exercise (a socio-economic analysis form). Most of the fields of the form are socio-economic in nature and only four fields have direct relevance to the shelterbelts, namely, fuel and fuelwood requirements, role of plantations during the tsunami, recommendations for plantations and plant species needed for plantations. Thus, it seems the processes lack true understanding and participation on the part of the stakeholders.

A review of the reports and plans from five districts, namely, Nagapattinam, Tuticorin, Pudukottai, Thiruvallur and Thirunelveli reveal the following (from Rodriguez 2007):

- Elements of equity in the process of choosing the entry point activities and its beneficiaries are not clear (some entry point activities involve individual beneficiaries for example distribution of goats). This raises questions of

transparency and equity.

- The PRA format suggests that it is only a socio-economic survey with very little space for community participation. The use of the term PRA is misleading.
- In the village micro-plans, aspects on tenure of land, access, rights and benefits are not clear and in most cases are absent.
- The response of the community has been lukewarm and their understanding of the Emergency Tsunami Reconstruction Project poor.
- Surveys were done in too short a time to ascertain the needs and aspirations of the community.
- There is very poor participation of women in the VFCs and in the PRA exercises.

Communities and Beach Space

Local communities have diverging opinions about coastal plantations. Access to and visibility of the seashore and sea is crucial for fishermen in their daily decision-making—a part of the fishery livelihood. In addition, the beach is also used for fishing activities such as fish drying and mending of nets.

It is also well known that the communities do not want 'shelterbelts' or any form of vegetation in front of their hamlets. Hence, one rarely finds shelterbelts being located directly in front of a fishing settlement. Communities have cited the following reasons for opposing bioshields:

- Communities want physical and visual access to the shore which is crucial to the application of traditional ecological knowledge such as *mappu*—the sighting of fish from the shore to decide whether to go to fish or not—measurements of winds, currents and tides and so on (Rodriguez 2007).

- Communities use the beach space for landing and storage of craft and gear.
- The beach space is used for repair of nets.
- Shore seine fishing requires large beach areas and this is hampered by coastal plantations.
- Vast beach areas are required to dry fish particularly during a time of good harvest. Without this space, the fisherfolk incur losses due to spoilage of fish catch.
- Among the above, beach seine and fish drying use significant amount of beach space both horizontally along the coast as well as vertically inland. At times these extend beyond villages' housing space.

Despite this, literature supporting plantations as bioshields have often been singularly gleaned out and cited to further plantation efforts in various places.

Access, Rights and Tenure

In spite of the ecological concerns, *Casuarina* is being planted as 90 percent of the composition of the plantation. Given the economic returns and potential uses of these plantations (for fuelwood and other purposes by the community), the absence of clarity on tenure of land, access, rights and benefits in the village micro-plans is conspicuous, and could be a possible cause for conflicts in the future.

It is interesting to note here that there are a lot more facets to bioshields than their expected role in coastal protection alone. The socio-economic aspects of bioshields are equally (if not more) significant. In Andhra Pradesh for instance, bioshields are currently (2002–07) being funded by another World Bank initiative, the Andhra Pradesh Community Forest Management (APCFM) project. Thus, it is neatly nested within the JFM or community forest management paradigm, which aims primarily at



reducing natural resource dependence on reserve forests and improving rural livelihoods. The economic returns from casuarina plantations are quite substantial for the local communities engaged in such activities [INR 60,000 per acre after 4 years in Andhra Pradesh (Forest Department records)]. In addition, the local communities have access to fuelwood collection and small timber after the fourth year of plantation. For marginalised fisherfolk communities living in remote areas along the coast, this forms a vital resource.

Policy Recommendations

The need of the hour immediately after the tsunami was to look at bioshields from an all-inclusive interdisciplinary perspective rather than promote and bolster a system that already existed as a ready solution. In our opinion, a complete assessment and documentation of species diversity of native habitats along the coast should have been attempted, at least at a landscape level. The effects of bathymetry and vulnerability of the coast to natural hazards should have been mapped meticulously along the entire coastline. Such studies would have proven more valuable in the face of future natural calamities rather than restrict the focus of current research to the past tsunami which in any case has a longer time scale of re-occurrence. Further research needs to strengthen not only the contested protective role of such vegetation structures but also the public opinion about such initiatives. Science should focus on identifying alternatives to bioshields as a means of livelihood, and natural resource (fuelwood, timber) needs require to be addressed in areas where the socio-economic dependence on bioshields is substantial. In brief, a single simplistic approach, as being practiced currently in these states, is certainly not the best option.

Ecological Measures

Though vast areas have been converted to plantations, most of these bioshields remain primarily monoculture plantations. Caution needs to be adopted while this rapid 'greening of the coast' is taking place. Scant attention has been paid to the ecology of the species being planted (particularly for natural coastal forests like mangroves) in such 'restoration efforts'. Very little science has been used either in the formation of policies governing bioshields or in the implementation of the same. Natural habitats like sand dunes and sandy shores continue to be destroyed by plantation of exotics like *Casuarina*. In this context, it is vital to rethink and revise the bioshield implementation plans on a regional scale.

In this regard, we recommend that:

- It is crucial to leave at least some natural habitats intact, without any human interventions like bioshields. A land use and management plan needs to be developed based on an ecological perspective. This plan may suggest a range of management options ranging from no intervention and no extraction to intensive restoration and resource use methods.
- Emphasis should be laid on the protection and conservation of remnant natural coastal ecosystems like sandy shores and sand dunes.
- The effectiveness of plantations as bioshields needs to be looked into in greater detail. A site specific reconnaissance survey should be done before the implementation of the plantation programme to account for natural habitats being impacted and the suitability of a bioshield in that area.
- Long term monitoring of these 'restored sites' or shelterbelts is essential to evaluate their sustainability in the long run.

Socio-economic Measures

The socio-economic aspect of bioshields is an extremely sensitive issue. While natural scientists may choose to be blinkered about the local community dependence on these plantations, it is prudent to be considerate towards all stakeholders.

Here, we recommend:

- The participation and perspectives of local communities should be mandatory before choosing the sites as well as local species being planted. These should be incorporated in the management plans of the implementation agency (e.g., the Forest Department) along with clear details of

access, rights, tenure and benefit-sharing.

- Clear guidelines and processes for participatory planning should be developed for the programme. 'No intervention' should also be an option open to the communities as a choice.
- In areas where the local dependence on the plantations are relatively high and the plantations are being raised primarily to meet this demand, alternative locations should be considered for raising the plantations rather than raising it along the coast.
- Polyculture plantations suiting the local needs should be given preference over monoculture exotics.
- Unless the community so desires, no plantation should be undertaken on the spaces in front of a village.
- Alternative income generation sources should be considered where such plantations contribute significantly to the livelihoods.

Legal Measures

The ambiguity in relation to land tenure systems in CRZ I areas, (where several such plantations are being raised) needs to be resolved promptly. The CRZ notification 1991 had the potential to protect mangroves as it stated that all mangroves were to be classified as CRZ I. However, subsequent explanations that limited the protection only to mangroves of a certain size and more, as well as the non-recognition of these in the draft of finalised Coastal Zone Management Programmes have resulted in leaving mangrove areas unprotected.

At the time of the notification in 1991, coastal plantations may have not been identified as an activity requiring its own regulation under this law or even posing a threat to other coastal ecosystems. Nor did the question of coastal plantations as an effective protection measure arise. Therefore the CRZ offers little by way of policy





guidance for such activities on the coast; in fact it allows these activities just as it allows seawalls. The protection offered to mangroves and the management of these areas by other legislations needs to be examined.

Conclusion

In summary, the jury is still out on the effectiveness of bioshields in protecting coastal habitations from storm surges and future tsunamis. Despite the considerable debate in scientific circles over the efficacy and ecological impact of such plantations, several state governments proceeded to initiate and implement large-scale plantations along the coast of India with government and international donor funding. Finally, most of these plantations are not being planted in front of villages or hamlets where they could play such a protective role. This suggests strongly that science has had little or no role in influencing decisions in the aftermath of this disaster. While one does advocate further research to strengthen not only the contested protective role of such vegetation

structures and their potential impact, scientists need to work harder to influence policy and decision-making. The scientific community needs to recognise that numerous factors—social, economic and cultural—likely play a more significant role in decision-making.

Very little socio-cultural, socio-economic and legal perspectives have been incorporated in the formation of policies and guidelines governing bioshields, and in the design and implementation of the project.

For resilient, ecologically and socially functional coastal vegetations, there is a need to promote mixed-species planting with an emphasis on community participation and preferences, and utilisation of indigenous species. Proper site selection should incorporate a full understanding of the ecological importance of sandy beaches and sand dunes as coastal habitats. Any interventions should be undertaken behind any existing vegetation lines alone, where such plantations can have socio-economic impacts for communities.



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