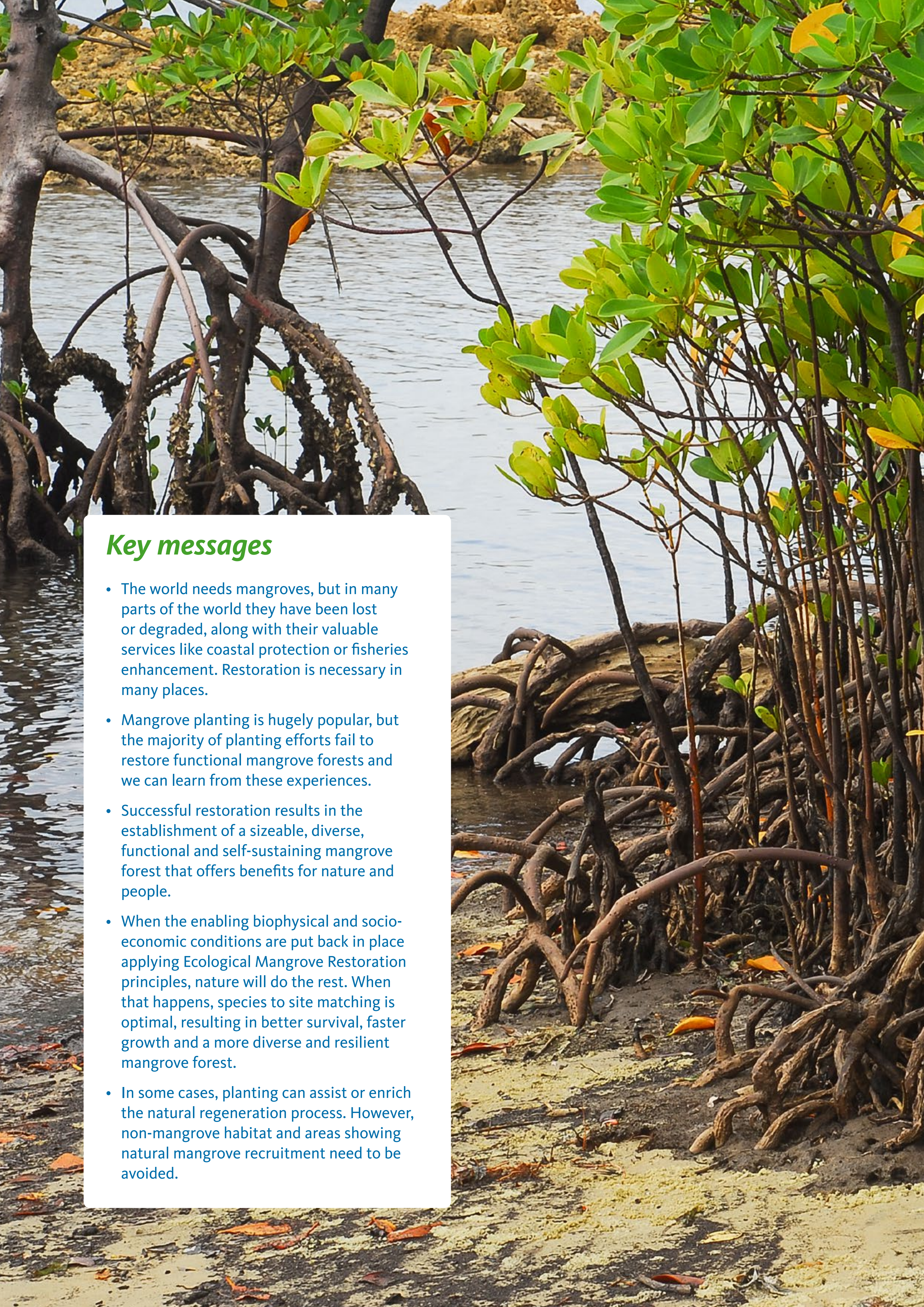
Mangrove restoration: to plant or not to plant?

Mangrove planting has become hugely popular. The majority of planting efforts are however failing. A more effective approach is to create the right conditions for mangroves to grow back naturally. Mangroves restored in this way generally survive and function better. This leaflet aims to contribute to best practice by exploring the question that everyone involved in mangrove restoration should ask: *'To plant or not to plant?'*



Key messages

- The world needs mangroves, but in many parts of the world they have been lost or degraded, along with their valuable services like coastal protection or fisheries enhancement. Restoration is necessary in many places.
- Mangrove planting is hugely popular, but the majority of planting efforts fail to restore functional mangrove forests and we can learn from these experiences.
- Successful restoration results in the establishment of a sizeable, diverse, functional and self-sustaining mangrove forest that offers benefits for nature and people.
- When the enabling biophysical and socio-economic conditions are put back in place applying Ecological Mangrove Restoration principles, nature will do the rest. When that happens, species to site matching is optimal, resulting in better survival, faster growth and a more diverse and resilient mangrove forest.
- In some cases, planting can assist or enrich the natural regeneration process. However, non-mangrove habitat and areas showing natural mangrove recruitment need to be avoided.

The world needs mangroves

Mangrove forests are under threat from many development pressures: overharvesting, pollution, conversion for agriculture, aquaculture or urbanization, oil and gas industry and development of infrastructure. In many parts of the world mangroves have been lost, along with their valuable services.

Generally speaking it is more cost-effective to prevent mangrove loss than to lose and restore them, but this is not always an option. Consequently, mangrove restoration is needed in many degraded areas across the world and if done properly, it will enhance coastal safety, fisheries, aquaculture and carbon sequestration.

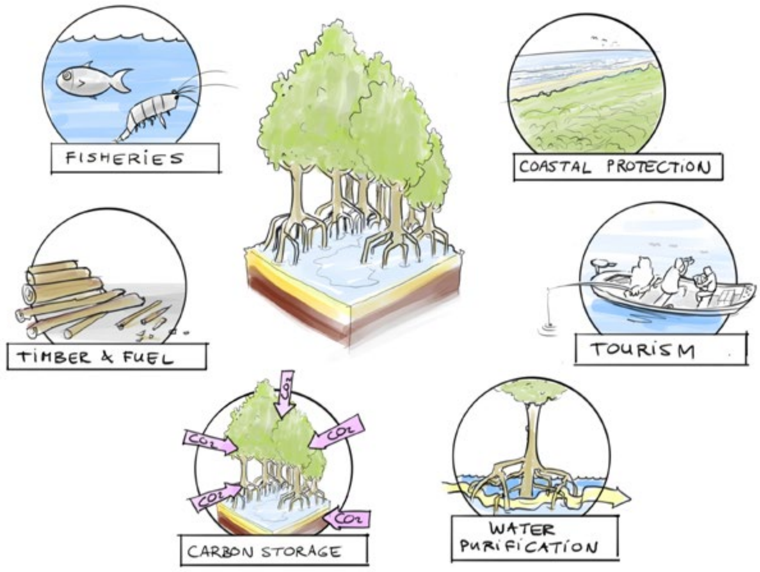
Mangrove planting is hugely popular, but not always effective

After the 2004 Indian Ocean tsunami, the importance of mangroves became widely recognized. Since then, mangrove planting has become very popular, with governments, NGOs, private sector, students, religious leaders and newly-weds planting mangroves or raising funds for others to plant. Across the globe hundreds of thousands of hectares of mangroves have been actively planted. Unfortunately, the majority of planting efforts fail to effectively restore functional mangrove forests and we can learn from these experiences.

Recurring factors for failure include:

- Planting in areas where socio-economic conditions are not right, because the local community is not involved, does not support the idea of conservation or because alternative livelihoods are lacking. For example when the community depends on aquaculture, so that mangroves are quickly reconverted to fish or shrimp ponds.
- Mono-species planting, leading to non-functional mangroves, with limited benefits and low resilience.
- Planting the wrong species in the wrong places, with mortality or slow growth as a result. For example, planting in areas that are under water for too many hours a day, or in areas too high up the intertidal range. Planting in places that are too exposed to waves and erosion or that do not have proper soil or water quality.
- Planting in places where the recovered mangrove would block sediment and water flows thus hampering recovery at a larger scale.
- Planting in areas where the original cause of loss (for example altered water flow) has not changed.
- Planting in places where mangroves are settling naturally, causing damage to the naturally regenerating mangroves and thus disturbing and slowing down natural recovery.
- Planting in areas that were not previously covered by mangroves, such as open intertidal mudflats or seagrass beds or sandy beaches, which causes damage to such valuable habitats (Box 3).

Box 1 Why ecologically restored mangroves survive and function better



Natural mangrove forests show a clear land-to-sea zonation with different species. This is because not all species can equally withstand the submerged conditions, wave exposure and salinity occurring at the seafront. Natural mangrove succession starts with pioneer species that facilitate colonization by many other species. Often, planted species are not pioneers and thereby the natural zonation and colonization process is disturbed.

Instead, when the enabling biophysical and socio-economic conditions are put back in place during restoration, nature will do the rest. Mangroves will grow back naturally, without planting, as propagules and fruits are swept in by the tides. If that happens, species to site matching is optimal, resulting in better survival, faster growth and a more diverse and resilient mangrove forest. In some cases, planting can assist or enrich the natural regeneration process.

Properly restored forests with multiple species and natural zonation show greater variety in root types, tree sizes, foliage and fruits, fulfilling different functions and attracting diverse (fish) fauna. This results in the provisioning of multiple goods (timber, fodder, honey, fruits, and fish) and services (enhanced coastal protection, carbon storage, water purification, fisheries enhancement). Ecologically restored forests are also likely to be more resilient to change because of this. Benefits are further optimised when connectivity with other habitats like seagrass beds or coral reefs is also re-established.

What is successful mangrove restoration?

The success of mangrove restoration is typically and pragmatically defined by the number of seedlings that have been planted and sometimes by the survival rate after a short period of time. However, many examples exist of planting efforts that demonstrate high survival initially but show high mortality in the longer run when monitoring has ended. Some efforts yield stunted single-species stands, growing at unnatural densities. Such 'mangroves' do not offer the coastal protection, fisheries enhancement or other benefits aimed for.

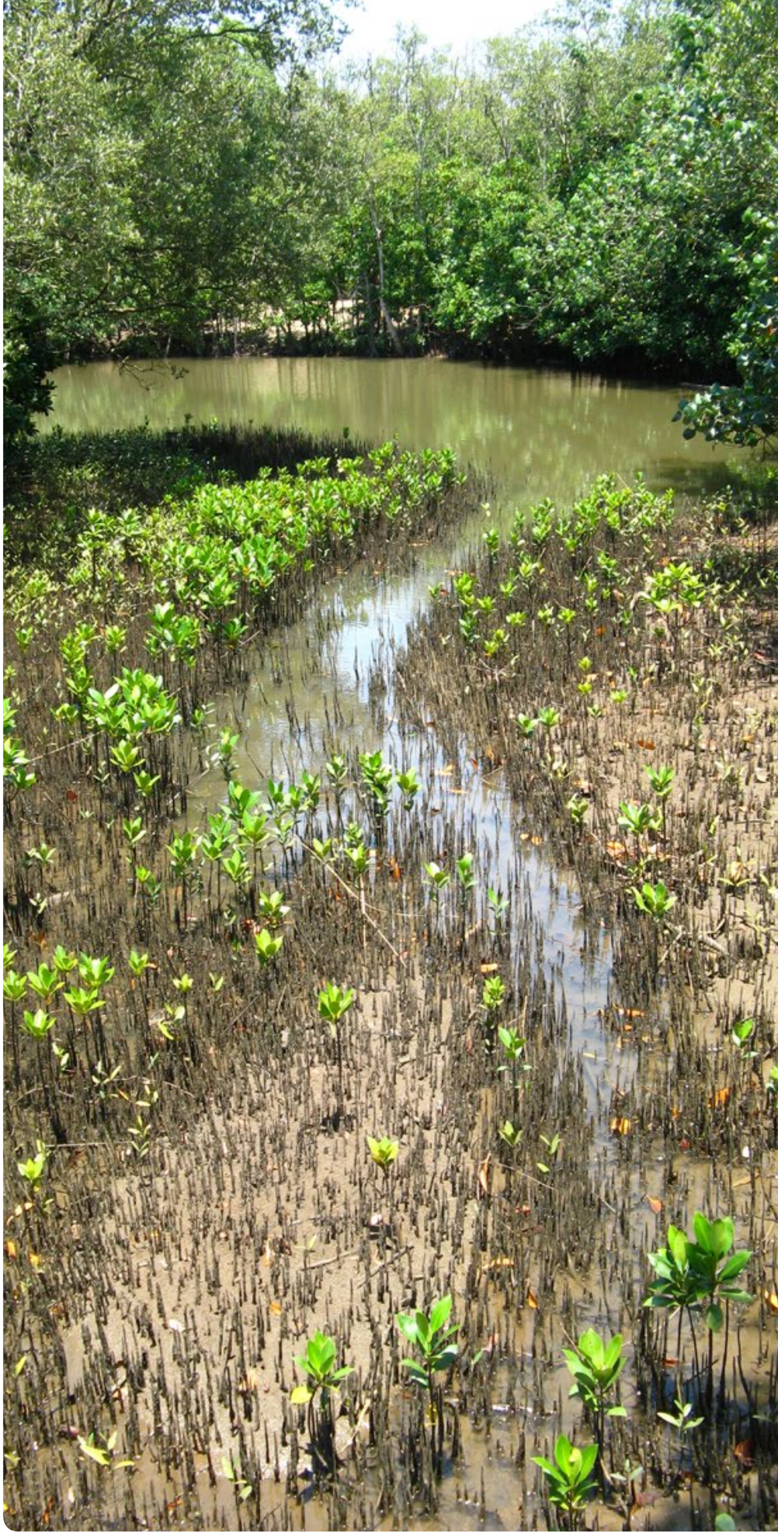
Instead, successful restoration needs to result in the establishment of a sizeable, diverse, functional and self-sustaining mangrove forest that does offer such benefits (see Box 1). With this in mind, it would be much better to measure success against the extent to which desired benefits for nature and people return and remain in place. There are many ways to do this, typically involving the assessment of diversity and abundance, vegetation structure and ecological processes in at least two reference sites to capture variation.

Principles for successful mangrove restoration

To channel the overwhelming enthusiasm for mangrove restoration to those interventions that are most effective (see Box 1), the following two principles are of key importance:

1. ***Ensure biophysical conditions are appropriate for mangrove recovery:***
   Mangroves may have been lost or degraded through conversion for other land uses, or as a result of changes in freshwater supply, loss of sediments or other causes. These in turn might be linked to local infrastructure developments and engineering works along coasts and rivers further away. Consequently, mangroves may no longer be able to thrive where they used to. Regeneration of a healthy mangrove forest can only happen if the enabling biophysical conditions for mangrove growth are put back in place. This can be hard – but very rewarding – work. In former aquaculture land, ground-levelling and restoration of hydrological flows is needed. This can be done by strategically breaching of pond bunds and restoring old creek systems. On rapidly eroding muddy coasts in Indonesia, Vietnam and Suriname, permeable structures are being applied to reduce wave impact, trap sediment and then allow natural mangrove recovery (see Box 2).

2. ***Ensure that socio-economic conditions allow mangrove recovery:***
   If mangroves have been removed by people this could easily happen again. The socio-economic root causes need to be addressed to prevent that. Where possible, economic activities need to be developed that sustainably benefit from the restored mangrove values, thereby strengthening the business case for restoration. Land ownership and use rights need to be established, and there must be both a desire for recovery and a possibility for management. Successful projects empower communities, engage local government and ensure that local actions are strengthened by policies and planning (see Box 4).



These two principles are the cornerstone of the so-called Ecological Mangrove Restoration approach, as developed by Lewis. This approach has a sound scientific basis. Strictly speaking, the term ‘restoration’ is reserved for the re-establishment of the pre-existing ecosystem; while ‘rehabilitation’ refers to recovery of ecosystem functions and processes without necessarily re-establishing the pre-disturbance condition. Note that the interventions involved in Ecological Mangrove Restoration are very different from restoration by planting only, and should be part of a coordinated programme involving experts of various disciplines – e.g. ecology, hydrology, coastal dynamics, sociology – as well as multiple stakeholders.

Box 2 *Permeable structures trapping mud for mangrove recovery*

Healthy mangrove mud coasts are in a dynamic equilibrium; waves take sediment away and tides bring sediment in. The mangroves' root system helps to capture and stabilize the sediment. Nowadays, many tropical mud coasts face dramatic erosion resulting from the conversion of mangroves, disturbing infrastructure, sea level rise and soil subsidence. Coastal managers tend to fight coastal erosion with hard structures, but these disturb the balance of incoming and outgoing sediment and may cause further erosion. To stop the erosion process and regain a more stable coastline, the first necessary step is to reverse the loss of sediment. Permeable structures made of local materials such as bamboo, twigs or other brushwood can be placed in front of the coastline. These structures let sea water pass through, dampening the waves rather than reflecting them. As a result, waves lose height and energy before they reach the coastline and mud can settle behind the structure. Once the erosion process has stopped and the shoreline starts accreting, mangroves can re-establish without being washed away. Over time, the mangroves themselves will attenuate waves and trap sediment again thus preventing erosion. This technique is currently being applied in the Mekong delta (Vietnam), in Demak (Indonesia) and along the coastline near Paramaribo (Suriname).

So, when to plant and when not to plant?

Ecological Mangrove Restoration relies on natural regeneration once biophysical conditions are restored, and planting is in most cases not needed. Yet, there are occasions when planting may still be useful. Sometimes planting is inevitable due to existing commitments or its current popularity with stakeholders. In those cases, planting efforts need to be channelled such that efforts are useful and do not result in failure or even damage to the environment. At the same time capacity building around Ecological Mangrove Restoration is required.

Planting might be valuable under the following conditions:

- Planting or sowing may be required when natural supplies of seeds and propagules are limited due to lack of nearby 'parent trees' or lack of hydrological connection to these trees (inhibiting dispersal of seeds and propagules). This is often the case along coastlines that suffered widespread mangrove degradation.
- Planting may also be done to re-introduce specific valuable species that have been lost from an area, so-called 'enrichment planting'.
- Planting can also be valuable for educational or cultural purposes. As a symbol of life, planting a tree can create lasting commitment and ownership amongst all those involved.
- In severely eroding areas, mangrove planting on remaining bunds can offer short-term relief by delaying erosion of those bunds.
- In cases were planting is deemed necessary, appropriate species to site matching is vital. Non-mangrove habitat and areas showing natural mangrove recruitment need to be avoided at all times (see Box 3).

Mangrove planting can of course also play a role even if ecosystem restoration is not the primary goal. For example, planting to provide a sustainable wood/ timber source. Also, mangroves are often planted in combination with aquaculture systems (silvofisheries), to introduce additional benefits in the system. The rows of mangrove trees that are planted along aquaculture pond bunds won't produce a 'real' mangrove forest, but may provide important benefits at the local scale like stabilisation of bunds, brushwood, fodder production and shade.

Communities may be used to the income they earn from nursery management and planting. A lot of their pride and ownership might be connected to the planting efforts. Ecological Mangrove Restoration needs to find alternative ways to practically engage the local community. For example in construction of permeable structures to trap sediment, breaching of bunds, sowing, monitoring and safeguarding the restored mangrove. Simultaneously sustainable livelihoods need to be developed to take the pressure off the recovered mangroves.

Box 3 *Where not to plant?*

Open intertidal mudflats, sand flats, coral reefs and seagrass beds often occur where mangroves can grow. These habitats support a high diversity of crustaceans, molluscs, coral, birds, mammals and turtles, including many threatened and endemic species. These habitats are highly productive and support a very high biomass of benthic invertebrates and other animals that sustain productive inshore and offshore fisheries. They provide extremely valuable feeding sites for billions of breeding and migrating waterbird species, including geese, ducks, shorebirds and gulls. In several places along major flyways of the world, mudflats and associated habitats serve as 'bottleneck sites' providing critically important resting and feeding sites for migratory waterbirds. Sites that support tens of thousands to millions of birds include the Gulf of Mottama (Myanmar), Panama Bay, Banc D'Arguin (Mauritania), Manila Bay, Inner Gulf of Thailand, Mekong Delta (Vietnam). Some are already designated as protected areas, Ramsar sites and World Heritage sites recognising their value for such wildlife. Converting these internationally important habitats through planting of mangroves can destroy vital habitat for these species and will contribute to their further decline.

Box 4 Ecological Mangrove Restoration as best practice in Indonesia

Between 1990-2004, 1200 ha of mangrove forest was converted into aquaculture ponds on Tanakeke Island, a low-lying atoll in South Sulawesi, Indonesia. As ponds became unproductive, villagers recognised the need to rehabilitate their mangroves for their fisheries and storm protection values.

In 2010, the village of Lantang Peo made 40 ha of ponds available for Ecological Mangrove Rehabilitation, which combines hydrological rehabilitation with ecological enhancement. Over the next 5 years, 6 additional villages followed suit, and today over 530 ha have been effectively rehabilitated, through a combination of activities including strategic breaching of dike walls, re-creation of tidal creeks, periodic dispersal of mangrove propagules and a minimal amount of planting. Natural recruitment became apparent within the first year after hydrological rehabilitation at each site, reaching densities of over 2500 seedlings per ha at time zero plus 3 years.

The total direct cost of rehabilitation amounted to 690,000 USD for design, implementation, management and monitoring, or 1300 USD/ha. Adoption at even larger scales (2000 – 20,000 ha) is being explored using the Restoration Opportunities Assessment Methodology developed by WRI and IUCN. It is expected that total costs can be reduced due to economies of scale.

Community based Ecological Mangrove Restoration is now formally included as best practice in the South Sulawesi Provincial and Indonesian National Mangrove Strategies. The Ministry of Environment and Forestry recommended the approach as a requisite for restoration of 4000 ha of converted mangrove in the Tanjung Panjang Nature Reserve in Gorontalo Province.

How can I support successful mangrove restoration?

Embrace the Ecological Mangrove Restoration approach and think twice before planting mangroves. Engage multiple experts and stakeholders, linking local knowledge to expertise of the scientific community.

Monitor and assess success against the desired purpose of restoration. Identify problems early and take corrective actions when necessary. Spread the word and share knowledge, experience and lessons learned.

Further reading:

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