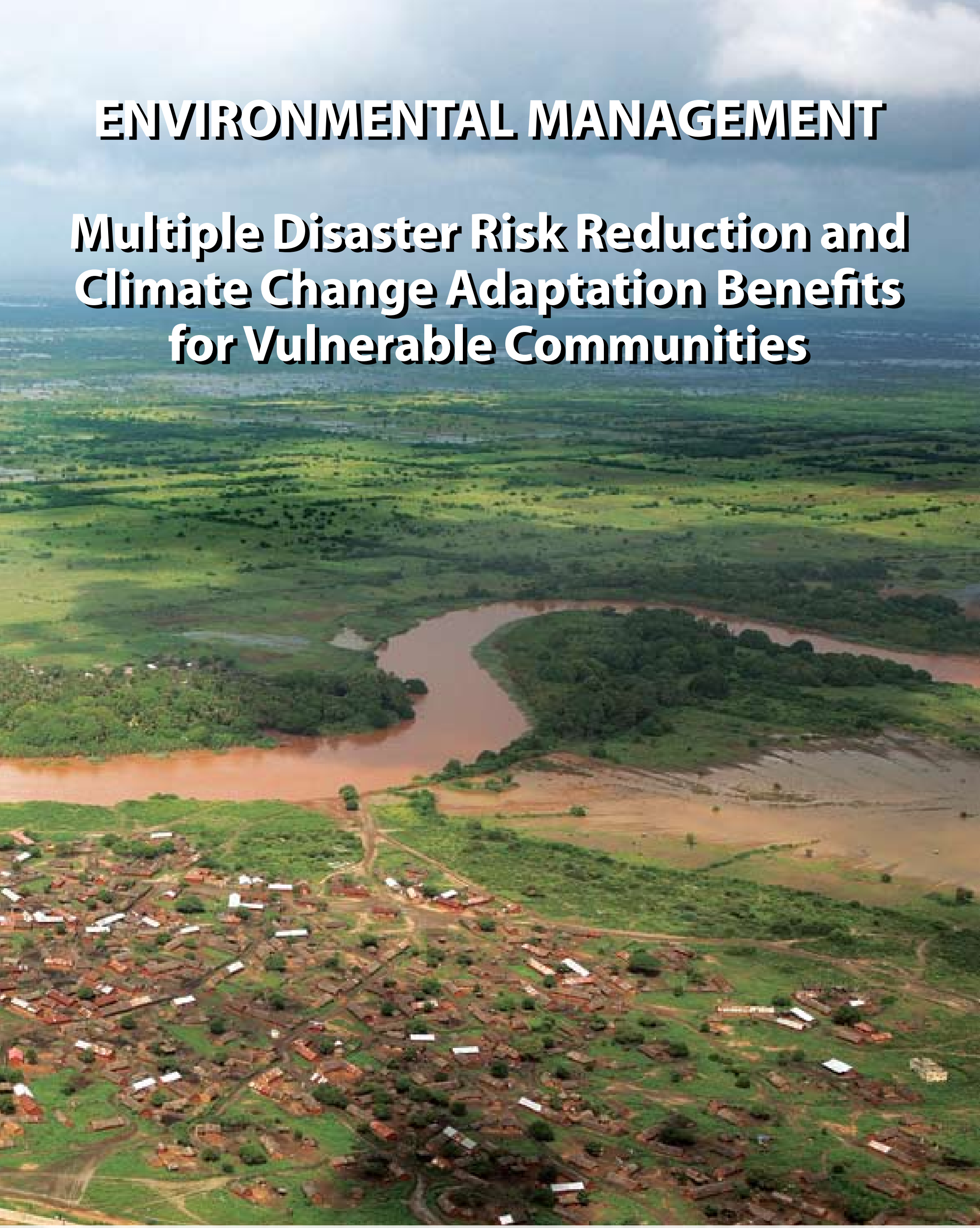
ENVIRONMENTAL MANAGEMENT

Multiple Disaster Risk Reduction and Climate Change Adaptation Benefits for Vulnerable Communities



ProAct network

environmental security and climate solutions for civil society

This brochure is based on resources from the report "The Role of Environmental Management and Eco-engineering in Disaster Risk Reduction and Climate Change Adaptation" (ProAct Network, 2008).

The full report, supporting references and case studies can be downloaded from www.proactnetwork.org

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THE OVERLOOKED ROLE OF ENVIRONMENTAL MANAGEMENT IN DISASTER RISK REDUCTION

"Communities will always face natural hazards, but today's disasters are often generated by, or at least exacerbated by, human activities."

Kofi Annan

Natural Hazards

Our planet is facing increasing frequency and intensity of disasters, both natural and man-made, many of which are having a devastating impact on society.

According to the secretariat of the International Strategy for Disaster Reduction (UN/ISDR), almost half a million people have been killed by disasters in the past ten years, while an additional 2.5 billion people have been affected in one way or another, with economic damages amounting to some US$690 billion. Most of these disasters – 97 per cent – were triggered by hydro-meteorological hazards.

The Intergovernmental Panel on Climate Change (IPCC) has "noted that "During the course of this century, the resilience of many ecosystems is likely to be exceeded by an unprecedented combination of change in climate, associated disturbances (e.g. flooding, drought, wildfire…) and in other global change drivers (especially land-use change, pollution and over-exploitation of resources)…".

This recognition comes at a time when a growing body of evidence suggests that we take a fresh look at the systems and approaches being put in place to prevent at least some natural hazards from taking their toll on humanity and the environment.

Hazard	Economic damage (US$ billion)	People affected (million)	Deaths
Flood	190	1,230	92,500
Earthquake and tsunami	120	40	400,000
Storm	426	362	176,150
Drought	30	1,100	460,000
Wildfire	19	0.5	480
Landslide and avalanche	15	26	80,000

Disaster statistics 1997-2006 (EM-DAT)

Natural Buffers

While an array of social and economic benefits have been documented in relation to healthy and intact ecosystems, the protective capacity of natural environments such as coastal ecosystems, vegetated slopes and undeveloped floodplains is only slowly being appreciated.

Ecosystems such as mangrove forests, coral reefs, floodplains and forests act as natural, dynamic barriers that can protect vulnerable communities against natural hazards such as floods, hurricanes, tsunami and avalanches.

Many traditional forms of hazard protection relied on hard engineered structures such as sea walls, river canal and sluice systems and avalanche barriers.

More recently, people have started to pay attention to the direct and indirect links between disaster risk reduction and the presence of intact and healthy ecosystems, particularly since the latter can:

- shield communities from at least some of the effects of many natural hazards;
- help maintain surface vegetation cover;
- reduce erosion;
- enhance biodiversity;
- generate livelihoods and security for local communities, and further afield;
- serve as a reservoir of resources, some of which might be beneficial to helping disaster-affected communities rebuild their lives and livelihoods following a disaster; and
- absorb and store greenhouse gases.

Forested slopes prevent landslides but also sequester carbon and produce oxygen, provide timber and non-wood products for communities, reduce erosion, secure clean and consistent supplies of water and enhance biodiversity.

A coastal forest that has been defoliated or partially destroyed by a storm surge will regenerate naturally, while a concrete sea wall will require costly repair work when broken.

Intact Not Degraded

To be effective in their role as natural buffers, ecosystems need to be in good health – a growing problem in many parts of the world. Increased human pressure on land and resources has already resulted in the complete clearance or widescale destruction of many ecosystems, removing or impairing their ability to function naturally. Sometimes this transformation is a deliberate choice, for example to create space for housing and construction or through conversion of coastal ecosystems to fish farms for short-term economic gains. In some – but not as many – instances, the transformation may also be a natural process.

Ecosystems are dynamic and constantly changing. They are not immune to damage. While the greatest damage to ecosystems comes from human exploitation and degradation, natural hazards also have an impact. During the 1979 tsunami and earthquake that destroyed the city of Tumaco on the Pacific Coast of Colombia, South America, a sand bar covered with mangrove forest received most of the wave energy, but was itself completely destroyed. In other extreme events enormous amounts of sediments can be displaced, transforming coastal features dramatically. Hurricane Mitch, for example, produced a new shoreline along the coasts of Honduras, while massive amounts of debris and sediment accumulated in the Gulf of Fonseca. Significant quantities of waste also enter ecosystems such as ground water reservoirs and coastal waters as a result of flooding and severe storms.

People-oriented Solutions

People are very much part of the process of maintaining – through effective management or landscape preservation – healthy ecosystems. As such, local communities must be included in initiatives designed to reduce the impact from natural hazards, particularly given current predictions that the scale, frequency and intensity of many hazards are expected to increase as a result of climate change.

Vulnerable communities may need to be assisted in such approaches given that some may currently have no option but to exploit key ecosystems. Longer term consequences need to be considered, particularly in areas where hazards occur on a repeated or seasonal basis. Cutting mangroves to provide construction materials following a cyclone, for example, may well leave coastal communities more vulnerable to future hazards.

Increasing attention is now being given to finding more sustainable alternatives to hard engineered defences as the latter are usually single purpose solutions designed with a specific tolerance in mind. Some may do little for a community except make it more vulnerable over time, as such defences can promote a high degree of false security. A 1992 review of floodplain management concluded that 60 years of building flood control structures in the Mississippi basin had not had any real effect in reducing deaths and property damage. The following year, after most of the river's catchment had received up to 200 per cent more rain than normal, unusually fast water flows hit the city of St Louis where the Mississippi and Missouri rivers meet, brushing aside the levees that hemmed it in: 487 counties in 9 states became flood disaster areas in a few hours.

Given the magnitude of climate change impacts and population pressure in vulnerable locations, increasing risks cannot be managed solely by building ever-bigger hard-engineered defences, especially in developing countries where the need for disaster risk reduction is most pressing and resources scarce. Compared with hard engineering approaches, natural protection structures can:

- enhance community ownership of disaster risk reduction;
- adapt to changing conditions, including recovering after a major damage-causing event;
- be more readily applied in poor countries as they are more cost-effective;
- be maintained with less external assistance; and
- prevent and reverse environmental degradation.

Hard protection structures, such as concrete sea walls and levees, will likely remain an important tool in disaster risk reduction. The key, however, is to allocate them to the most appropriate sites, such as where they alone can protect vital infrastructure or urban locations that cannot be relocated to safer places. In many instances though a combination of soft and hard protection measures should be considered.

Preventing LANDSLIDES AND AVALANCHES through ground cover maintenance

Landslides and avalanches involve a sudden and often massive displacement of soil, rocks, debris or snow down a slope. Such events are usually triggered by heavy rainfall, earthquakes, volcanic eruptions or human activities, or a combination of these.

Avalanche risk is related to slope angle and forest features, including the type of trees, gap size, tree density and crown cover. Trees, for example, reduce the risk of avalanches by:

- **breaking up snow cover;**
- **preventing wind-blown snow drifts;**
- **stabilising snow temperature; and**
- **anchoring snow and preventing it from moving.**

The root systems of trees and plants re-inforce and stabilise soil layers on steep slopes. Dense, deep-rooted trees and shrubs – especially forests – are most effective in minimising mass soil movements. Through this role, vegetation cover can prevent the occurrence of shallow landslides (<1-2m deep), whilst deep-seated landslides (>5m deep) on steep terrains are less influenced by vegetation cover.

Despite the potential of healthy or well managed forests to buffer the scale and impacts of landslides and avalanches, depending on the scale and speed of the event, once an avalanche has been released and has gained sufficient momentum, neither forest nor artificial protective structures may be able to stop its flow.

A study from Japan – with scientific data spanning 40 years – shows that forest cover can reduce landslide erosion by a factor of 4-5 compared with sites without substantial tree root strength.

Research following the October 2005 earthquake in Pakistan demonstrated a strong link between vegetation cover and land ownership and management regimes. Risks were found to be highest in deforested areas used that have been overgrazed, followed by land sculpted into terraces and steep areas used for housing.

Switzerland is one of only a few countries that has attached a clear protective role to its forests. The estimated economic value of forests in preventing avalanches ranges from less than US$100/ha/yr for some of the landscapes in the Swiss Alps to more than US$170,000/ha/yr for specific sites with valued assets such as tourist venues and towns.

Controlling FLOODS with naturally adapted ecosystems

Wetlands, floodplains and coastal deltas are some of the most densely populated places on Earth, partly on account of the high levels of biological diversity they support, much of which is of considerable economic value. In terms of hazard reduction, they also play an important role in:

- **retaining water, thus preventing possible flooding in other areas: 0.4ha of wetland can store over 6000m^3 of floodwater;**
- **slowing the velocity of floodwaters;**
- **dissipating storm surge energy; and**
- **reducing erosion and sedimentation by controlling the movement of soil particles.**

Floodplain forests and other vegetation cover can also have an important role in attenuating flood peaks, as well as providing other environmental services. Vegetation cover reduces local soil erosion as well as sedimentation downstream which, when severe, can itself congest drainage systems and promote flooding.

Wetlands and other natural "sponges" do not, however, influence the peaks of extreme flood events once soils are completely saturated.

An economic valuation of the unaltered Lužnice floodplain in the Czech Republic demonstrates the importance of its ecosystem services, including flood mitigation, biodiversity protection, carbon sequestration and fish and hay production. The carbon sequestration capacity of the floodplain is calculated at 7.5tCO_2e/ha, with a flood mitigation value close to US$12,000/ha/yr, while the overall value of ecosystem services studied was estimated at US$27,000/ha/yr.

Managed retreat or re-alignment – which involves the removal of an artificial coastal protection barrier in order to allow an area that was not previously exposed to flooding by the sea to become flooded – can be a viable and successful strategy to adapt to the impact of sea level rise and/or increased wave action on low-lying coasts.

A managed re-alignment programme at Freiston Shore, UK, has created a new saltmarsh habitat and saline lagoon. The existing hard sea defence was moved to a more landward location, allowing space for the creation of an intertidal habitat that, in turn, allowed enhanced flood water storage and wave attenuation. Saltmarsh grass vegetation for example can reduce wave heights by 70 per cent and wave energy by over 90 per cent. This coastal defence project protects more than 80,000ha of low-lying land, including several villages.

Coastal ecosystems protecting against SEVERE STORMS and TSUNAMIS

Mangroves, saltmarshes, beach vegetation, seagrass beds and coral reefs all serve as effective buffers against coastal hazards as they help:

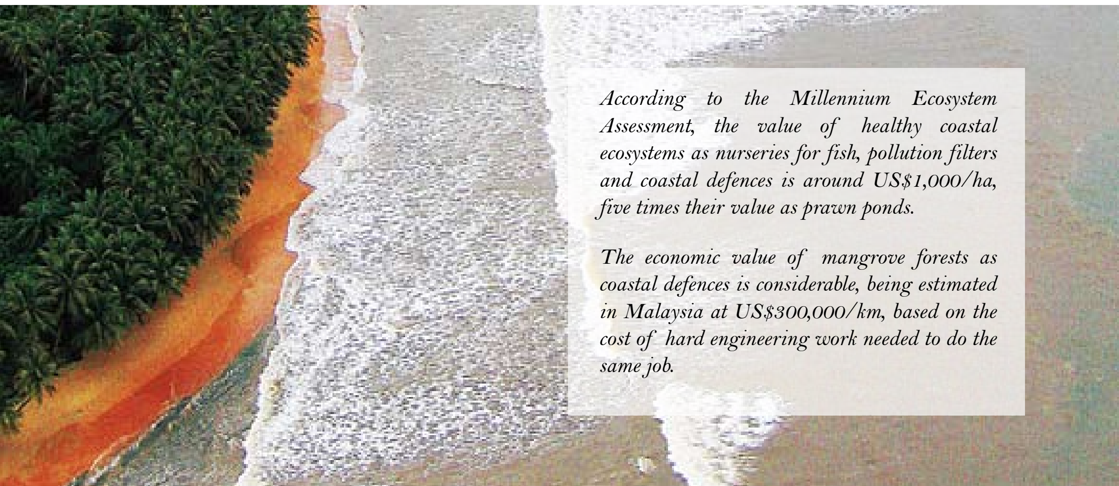
- **reduce the magnitude of storm surges;**
- **absorb storm energy;**
- **reduce flow depths and velocities; and**
- **hold sediments in place.**

An example of how these differences apply in practice emerged following Hurricane Mitch. As a result of this event, mangroves on the Caribbean islands were damaged mostly by the wind and storm surges, while those on the mainland Caribbean were damaged by strong waves, erosion and deposition of sediments, and mangroves along the Pacific were buried under sediments deposited by rivers as a consequence of upland erosion by strong rains.

Mangrove forests have a particularly well-known capacity to attenuate storms, on account of their physical sturdiness and complexity, with stilt roots and other structures that help to absorb wave energy.

The protective role played by coral reefs is more evident during storm events than for much larger tsunamis. Nonetheless, research following the 2004 Indian Ocean tsunami described that in areas fringed by coral reefs run-up waves were only 2-3m and reached 50m inland, whereas in areas without coral reefs the highest waves were 10m and run-up waves that penetrated 1.5km inland.

In the case of tsunami – possibly the most significant and powerful coastal threat – well-planned and managed coastal ecosystems can provide protection against waves up to 6-7m high. A very large tsunami, however, may overwhelm any kind of buffer – natural or artificial – and major destruction is likely inevitable.



According to the Millennium Ecosystem Assessment, the value of healthy coastal ecosystems as nurseries for fish, pollution filters and coastal defences is around US$1,000/ha, five times their value as prawn ponds.

The economic value of mangrove forests as coastal defences is considerable, being estimated in Malaysia at US$300,000/km, based on the cost of hard engineering work needed to do the same job.

Mangroves are also very productive ecosystems that help support the livelihoods of millions of coastal inhabitants. In Bangladesh the coastal forest ecosystem can yield an annual harvest per hectare of 100kg of fish, 20kg of shrimp, 15kg of crabmeat, 200kg of mollusc and 40kg of sea cucumber. More than 70 other uses for mangrove products have been documented worldwide, ranging from builing materials to medicines.

Recognising the important defence role played by selected coastal wetlands, a US$14 billion wetland restoration programme, "Coast 2050" was initiated in Louisiana, USA, to protect more than 10,000km^2 of marsh, swamp and barrier islands, the latter in particular being recognised as the state's first line of defence against storm surge generated by hurricanes. The need to strengthen this approach became more evident in the aftermath of the damage caused by Hurricane Katrina when the hard engineered flood protection system failed in 53 different places.

In Sri Lanka, the Sewalanka Foundation assists in restoring mangroves and other coastal vegetation in lagoon shores and beaches affected by the 2004 Indian Ocean tsunami. This programme is based on the active participation of local Panama and Turkkovil communities and aims to enhance their adaptive capacity to extreme climate events and sea level rise. With assisted regeneration, mangroves and beach vegetation are expected to have re-grown enough to offer significant coastal protection within 10 years, while the accretion of sand and sediment should make a significant difference within 15 years.

Due to the lack of alternative livelihood options, local communities are often heavily dependent on natural resources, including mangroves. This dependence could lead to future degradation of the mangrove and beach vegetation for example through over-harvesting. However, in view of the participatory nature of the project, together with community capacity building and environmental education, this risk is likely to be less significant than if re-vegetation had taken place without consultation or active participation of local stakeholders.

Breaking the cycle of DROUGHT AND DESERTIFICATION

Drought and desertification are slow processes that involve damage to vegetation cover and the land, through desiccation and wind erosion.

Planting trees and shrubs as shelterbelts, greenbelts, hedges and living fences help break the force of the wind but also importantly provide shade for the soil, bind the soil together through their roots, trap water and restore organic material.

Practical agricultural practices that can be adopted to help prevent or overcome desertification include:

- using drought- and salt-resistant crops;
- rotating crops and grazing with fallow periods;
- using mixed planting and cropping through agroforestry, which involves growing a selection of compatible trees and other crops together, for multiple benefits; and
- mulching, which involves covering the soil with crop residues, leaves or porous rocks to reduce erosion and evaporation.

Losing their land to desertification, communities in Dan Saga, Niger, decided to plant and protect young trees in a bid to save their livelihoods. In time the trees began to halt the advance of the spreading sand and today the trees are part of a recognised farming system that also provides fodder for livestock, so farmers get more manure for their fields. Through this simple, but appropriate approach, Niger may have gained 200 million trees in two decades.

Reducing the impact of SAND STORMS

Sand storms cannot be controlled directly but their tendency to develop as well as their impact can be reduced through measures that include:

- **planting windbreaks of tall, dense vegetation that reduce wind speeds;**
- **removing land from agricultural cultivation and planting it with forest and grasses;**
- **establishing protective oasis and farmland shelterbelts and windbreaks;**
- **maintaining soil structure by keeping crop residues on the land after harvest; and**
- **planting seedling trees and shrubs to stabilise advancing dunes.**

In Canada, at least 161 million tonnes of soil is lost each year because of wind erosion. During the Dust Bowl period of the 1930s, some areas lost all of their topsoil. In response, the Prairie Farm Rehabilitation Administration was established in 1935. Improved agricultural practices, such as planting of barriers and buffers, and zero/minimum tillage were implemented.

Barriers such as shelterbelts consist of rows of trees planted on agricultural land to protect crops and soil, to catch and distribute snow, and to improve the microclimate for crops. Shelterbelts can reduce wind speeds for a distance of 20-30 times their own height and increase crop yields considerably. They also offer habitat for wildlife and provide products such as wood and fruit. In addition, trees can also be used to shade buildings and reduce direct exposure to the sun.

Reducing WILDFIRES by managing fuel load

Wildfires can have a devastating effect on the environment and also result in significant economic losses. Where wildfires are a recurrent feature, or if an area might occasionally be susceptible to fire, controlled burns or prescribed fires are applied to specific areas under relatively safe conditions. Controlled burning early in the dry season or in calm or cloudy weather removes dead and dying vegetation and reduces the risk of larger, uncontrolled wildfires at some later stage.

Parallel benefits of this are:

- **improved native plant and animal habitat;**
- **controlled the spread of noxious and invasive weeds; and**
- **restored productivity of grazing lands.**

Another solution is to physically remove potential fuel through, for example, artificial creation of a firebreak or gap in the vegetation that acts as a barrier to slow or stop the progress of a wildfire. Firebreaks may be man-made or they can occur naturally where there is a lack of vegetation, such as along a river.

The Western Arnhem Land strategic fire managing programme in Northern Australia is a collaborative scheme between a gas refinery (payment for carbon offset services), a regional administration (facilitation) and aboriginal communities (traditional fire management), generating multiple benefits, such as:

- environmental benefits that include the reduction of greenhouse gas emissions – some 100,000 t CO_2e/year – and ecosystem degradation;
- economic benefits include increased employment and economic participation of aboriginal communities, the avoided economic costs of destructive wildfires and associated loss of biomass and ecosystem services; and
- social benefits include enhancement of traditional indigenous culture related to fire and the increased participation of aboriginal communities.

10 KEY MESSAGES

1. Recognise that many traditional forms of hard defences will not be able to cope with the growing threats from climate change.

2. Learn from the experiences where an active decision has been taken to remove artificial barriers in favour once again of a natural environment.

3. Use proven eco-engineering solutions as a practical and appropriate means of disaster risk reduction and implement such solutions through mechanisms that include UN conventions, regional co-operation agreements and ongoing and planned development programmes.

4. Invest further in site- and hazard-specific research – particularly where vulnerable communities and regions can already be identified – to determine how communities might become more involved in and responsible for environmental management as a natural buffer.

5. Give particular attention to supporting national and local actions that link disaster risk reduction and climate change adaptation agendas, highlighting the added potential for social and economic benefits.

6. Sensitise policy-makers and donors on the measurable adaptation and mitigation effects of well-managed ecosystems, which include the potential of reducing disaster risk (adaptation) and capturing carbon dioxide (mitigation).

7. Highlight the multiple benefits of intact and well managed ecosystems and integrate existing lessons on environmental management into negotiations for climate change mitigation and adaptation.

8. Encourage and enable technology transfer so that a mix of best practices and lessons learned can be tailored and applied to specific situations.

9. Explore financing opportunities through climate change funding in order to facilitate implementation of disaster risk reduction projects combining adaptation with mitigation.

10. Natural buffers cannot offer complete protection, and should be used with other risk management components, such as early warning systems.

ADDITIONAL RESOURCES

This brochure is based on resources from the report **"The Role of Environmental Management and Eco-engineering in Disaster Risk Reduction and Climate Change Adaptation"** (ProAct Network, 2008). The following case studies were commissioned specifically for the report:

Tropical Coastal Ecosystems as Defence Mechanisms
Prepared by Carmen Lacambra, Dr Tom Spencer, Dr Iris Moeller, Cambridge Coastal Research Unit, University of Cambridge, UK

Disaster Mitigation and Prevention through Restoration of Littoral Vegetation, Sri Lanka
Prepared by the Mangrove Action Project

Strengthening Decision-making Tools for Disaster Risk Reduction, Northern Pakistan
Prepared by IUCN Pakistan

Slope Stability: Benefits of Forest Vegetation in Central Japan
Prepared by Dr Roy Sidle, Disaster Prevention Research Institute, Kyoto University, Japan

Quantifying the Protective Capacity of Forests against Snow Avalanches, Switzerland
Prepared by Dr Perry Bartelt, SLF, Switzerland

Managed Re-alignment and the Re-establishment of Saltmarsh Habitat, UK
Prepared by Daniel Friess, Dr Iris Möller, Dr Tom Spencer, CCRU, Cambridge University, UK

Ecosystem Services of a Floodplain with a Preserved Hydrological Regime, Czech Republic
Prepared by Dr David Pithart, Academy of Sciences, Czech Republic

West Arnhem Fire Management Agreement, Australia
Prepared by Tropical Savannas CRC, Australia

Permaculture in the Jordan Valley
Prepared by Permaculture Research Institute of Australia

Sand Storms
Prepared from a literature review by ProAct Network

All texts can be downloaded from www.proactnetwork.org

PROACT NETWORK

ProAct Network – a non-profit international network of environmental professionals and partners – promotes environmental security and climate change solutions through sound environmental management. Its ultimate objective is to reduce disaster vulnerability and help minimise the impact of disasters on communities, as well as to help ensure that neither peoples' livelihoods nor the environment are unnecessarily impaired during disaster recovery and rehabilitation.

Key areas of ProAct's work in support of disaster risk reduction and climate change adaptation are:

- *Technical advice and research on possible disaster impacts and the subsequent integration of disaster risk reduction and climate change adaptation into relief, rehabilitation and development programming, strategy and policy.*
- *Capacity strengthening of local institutions in support of effective and sustainable community-based resilience to natural hazards and climate variability through practical hands-on support at the field level.*
- *Protection and re-establishment of ecosystems and ecosystem services for environmental and livelihood security in both development programming and in post-disaster activities.*
- *Engagement in the Nairobi Work Programme and UNFCCC negotiations to support practical adaptation and the integration of environmental management based disaster risk reduction knowledge and experience in the adaptation pillar of the "post 2012 framework".*
- *Engagement in stakeholder progress implementing the Hyogo Framework for Action 2005-2015 in particular to support the integration of risks associated with climate change (and the need for adaptation), and the effectiveness of the Framework in leading to a reduction in the underlying causes of vulnerability, recognised by improved resilience at the local level.*
- *Innovative approaches to risk reduction such as through the development of AdMit and MitAd funding opportunities.*
- *Knowledge gathering and sharing of ecosystem values in disaster risk reduction and climate change adaptation based on research and documentation.*

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