



International Strategy for  
Disaster Reduction

# Guidance Note on Recovery

# ENVIRONMENT



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**IRP** was conceived at the World Conference on Disaster Reduction (WCDR) in Kobe, Hyogo, Japan in January 2005. As a thematic platform of the International Strategy for Disaster Reduction (ISDR) system, IRP is a key pillar for the implementation of the Hyogo Framework for Action (HFA) 2005-2015: Building the Resilience of Nations and Communities to Disasters, a global plan for disaster risk reduction for the decade adopted by 168 governments at the WCDR. The key role of IRP is to identify gaps and constraints experienced in post disaster recovery and to serve as a catalyst for the development of tools, resources, and capacity for resilient recovery. IRP aims to be an international source of knowledge on good recovery practice. IRP promotes “Build Back Better” approaches that not only restore what existed previously but also set communities on a better and safer development path and support development of enhanced recovery capacity at regional, national, and sub-national levels with particular focus on high-risk low-capacity countries.

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## **Introduction**

### **Purpose**

There is currently an abundance of documents, plans and policies that address common issues faced in the mitigation, preparedness and relief phases of natural disaster management. Yet for disaster recovery planners and policy makers, there is no cohesive documented body of knowledge. It is conceded that preventive measures are vital to reducing the more costly efforts of responding to disasters. Nevertheless, in the post disaster situation, the availability of knowledge products reflecting past practices and lessons learned is critical for effective and sustainable recovery. Unquestionably, a wealth of experience and expertise exists within governments and organizations; however the majority of this knowledge is never documented, compiled, nor shared. Filling this knowledge gap is a key objective of the International Recovery Platform and The Guidance Note on Recovery: Environment, along with its companion booklets, is an initial step in documenting, collecting and sharing disaster recovery experiences and lessons. IRP hopes that this collection of the successes and failures of past experiences in disaster recovery will serve to inform the planning and implementation of future recovery initiatives. The aim is not to recommend actions, but to place before the reader a menu of options.

### **Audience**

The Guidance Note on Recovery: Environment is primarily intended for use by policymakers, planners, and implementers of local, regional and national government bodies interested or engaged in facilitating a more responsive, sustainable, and risk-reducing recovery process. Yet, IRP recognizes that governments are not the sole actors in disaster recovery and believes that the experiences collected in this document can benefit the many other partners working together to build back better.

### **Content**

The Guidance Note on Recovery: Environment draws from documented experiences of past and present recovery efforts, collected through a desk review and consultations with relevant experts. These experiences and lessons learned are classified into four major issues:

1. Dealing with Disaster Debris
2. Implementing Environmentally Sound Reconstruction
3. Promoting Environmentally Sustainable Livelihoods
4. Rehabilitating Ecosystems

The materials are presented in the form of cases. The document provides analysis of many of the cases, highlighting key lessons and noting points of caution and clarification.

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The case study format has been chosen in order to provide a richer description of recovery approaches, thus permitting the reader to draw other lessons or conclusions relative to a particular context.

It is recognized that, while certain activities or projects presented in this Guidance Note have met with success in a given context, there is no guarantee that the same activity will generate similar results across all contexts. Cultural norms, socio-economic contexts, gender relations and myriad other factors will influence the process and outcome of any planned activity. Therefore, the following case studies are not intended as prescriptive solutions to be applied, but rather as experiences to inspire, to generate contextually relevant ideas, and where appropriate, to adapt and apply.

# A Working Definition of Environment

## ***Environment***

The word ***environment*** is most commonly used in reference to the "natural" environment, or the sum of all living and non-living things that surround an organism, or group of organisms. The natural environment comprises physical components such as air, temperature, landforms, soils and water bodies as well as living components such as plants, animals, and microorganisms. In contrast to the "natural environment, there also exists the "built environment", which comprises all human-made elements and processes. Usage of the word within this document includes both the natural and the built environment, or "All of the external factors, conditions, and influences which affect an organism or a community" (UNEP).

## ***Ecosystems***

The elements within an environment do not exist in isolation, but as part of a system of processes that link them together. For the purpose of this document, ecosystem is defined as "a dynamic complex of plant, animal, and microorganism communities and the nonliving environment interacting as a functional unit. Humans are an integral part of ecosystems. Ecosystems vary enormously in size; a temporary pond in a tree hollow and an ocean basin can both be ecosystems" (UNEP). Common examples of ecosystems are wetlands, coasts, and forests. Within each ecosystem may be found smaller ecosystems – for example, reef ecosystems typically form part of larger coastal ecosystems.

**NOTE:** Urban environments are also part of various ecosystems. Therefore ecosystem-related references within this document include both "green" environmental issues (reducing the impact of production, consumption and waste generation on natural resources and ecosystems) and "brown" environmental issues (reducing the environmental threats to health that arise from poor sanitary conditions, crowding, inadequate water provision, hazardous air and water pollution, and local accumulations of solid waste)

### ***Ecosystem services***

Ecosystem services are the benefits that people obtain from ecosystems (UNEP). Many ecosystem services, such as the purification of water and the oxygen cycle are essential to sustaining life. Ecosystem services can be categorized as provisioning, regulating, cultural and supporting services. With respect to natural disasters, this document will also make reference to the protective services that ecosystems provide to prevent or mitigate disasters.

#### **Box 1. Ecosystem services**

<b><i>Provisioning services:</i></b>	The goods provided by ecosystems (e.g. food – plants and animals, water, raw materials for production, and many medicines).
<b><i>Regulating services:</i></b>	The benefits provided by regulatory processes of ecosystems (e.g. climate regulation, water purification, and crop pollination).
<b><i>Protective services:</i></b>	The protection afforded to humans against extreme natural events through ecosystem features and processes (sand dunes, reefs, forests, and wetlands).
<b><i>Supporting services:</i></b>	The most general ecosystem services necessary for all living things to survive (e.g. production of atmospheric oxygen, soil formation, nutrient cycling, and water cycling).
<b><i>Cultural services:</i></b>	The non-material benefits people obtain from ecosystems through reflection, recreation, and aesthetic experience (e.g. scientific discovery, aesthetic values).

### ***Ecosystem resilience***

This is the level of disturbance that an ecosystem can undergo without crossing a threshold to a situation with different structure or outputs. Resilience depends on ecological dynamics as well as the organizational and institutional capacity to understand, manage and respond to these dynamics (UNEP).

# Why Consider the Environment?

## *Disasters and the environment*

Disasters and the environment are inherently linked. What we call “natural disasters” are naturally-occurring extreme events that take place within an ecosystem. These extreme natural events are the result of a change in conditions within an ecosystem. Sometimes the change may be a sudden increase in temperature that causes mountain snow to rapidly melt; overflowing streams and rivers and provoking floods. Sometimes an extreme event occurs as the result of slow change over a long period of time, such as desertification. Sometime the extreme event may be a regularly-occurring process, such as the flooding of semi-arid lands that serves to recharge ground water systems and provides nutrients to soil.

Equally important is the role that ecosystems play in preventing or mitigating damage resulting from these extreme events. Sand dunes, mangroves and coral reefs absorb the energy of powerful waves induced by tropical cyclones. Coastal forests may serve as wind barriers protecting inland areas from wind damage while trees and vegetation cover stabilize slopes preventing mud and landslides. Wetlands absorb increased water flows, reducing the frequency and intensity of floods, while filtering and recharging aquifers.

### Box 2. Performance of sand dunes in Tamil Nadu

Damage assessments from post-tsunami Tamil Nadu, India indicate the importance of sand dunes in diminishing tsunami wave impacts:

The Nanjalingsampettai coast is characterized by dunes more than 5 m high and very steep seaward gradients. The wave up-rush of 3.7 m stopped at the dune. It is pertinent to note that there was no damage to any habitation behind dune complexes; coconut trees and casuarinas also acted as natural protection. Inundation of 372 m is attributed to over wash through gaps on dunes due to trampling.

The Tarangambadi sea shore was occupied by dense dwellings. Sand dunes had been removed in favor of houses. The wave run-up of 2.4 m bypassed the flat beach thus razing whatever came its way. Inland inundation was 401 m. Coast perpendicular roads over the dunes also contributed to the invasion of tsunami waters. Lacked natural protection, all the beach front houses disappeared

Source: National Institute of Oceanography, India, Retrieved from [http://drs.nio.org/drs/bitstream/2264/1393/4/J\\_Environ\\_Mgmt\\_89\\_24p.pdf](http://drs.nio.org/drs/bitstream/2264/1393/4/J_Environ_Mgmt_89_24p.pdf)

### ***Human impacts on ecosystems***

Ecosystems are typically very resilient. Many have sustainably supported human needs for thousands of years. However, industrialization, population growth, and the unsustainable management of natural resources have greatly weakened many ecosystems - sometimes beyond repair. An example of this is the extensive deforestation of Haiti that has led to a state of near constant food insecurity for many of its poorest populations.

*Haiti is increasingly losing its productive potential. Due to the loss of its vegetative cover, it is also beginning a process of desertification. Only 1.5% of Haiti's natural forest remains and 25 to 30 watersheds are denuded. Deforestation of Haiti's mountainous countryside has resulted in extensive soil erosion. An estimated 15,000 acres of top soil are washed away each year, with erosion also damaging other productive infrastructure such as dams, irrigation systems, roads, and coastal marine ecosystems. The growing gap between fuel-wood supply and demand is exacerbating environmental degradation as peasants cut the few remaining trees to produce charcoal (USAID, 2000).*

Damaged ecosystems can be rehabilitated. Additionally, new approaches and methods are being identified and implemented to manage human resource needs without destroying the ecosystems which provide them. However restoring an ecosystem takes considerably more time than degrading it, and once the carrying capacity of an ecosystem has been overwhelmed, it may take generations to regenerate. In some cases it may never do so.

### ***Human influence on natural disasters***

Environmental degradation, brought on by human activity, has also contributed to an increase in the frequency and intensity of natural disasters. By exploiting the many goods and services offered by ecosystems, humans have inadvertently damaged and destroyed the protective services they offer.

- ***The clear-cutting of forested slopes*** has decreased soil stabilization and led to numerous landslides and mudslides burying neighborhoods below.
- ***The excavation of dunes*** for tourism development and building materials, has removed the natural barriers that formerly protected coastal inland environments, and human settlements, from the direct force of storm waves

and hurricane winds. Mining sand from the dunes for reconstruction can further debilitate their protective capacity.

- ***The draining of wetlands*** for agriculture and human settlement has resulted in severe flooding along lakes, rivers, and other water bodies. Such flooding can rob soils of nutrients (diminishing agricultural production) and pollute water bodies with chemical pesticides and fertilizers.

Humans have also consistently attempted to control the occurrences of certain hazard events such as floods. Yet, without an adequate understanding of the potential direct and indirect consequences throughout and across ecosystems, many of these interventions have only exacerbated the problem, and in many cases provoked a string of new ones. A poignant example of this is the series of interventions to harness the Mississippi River system and delta for production purposes, which ultimately contributed to the devastation of the city of New Orleans, following the 2005 Hurricane Katrina.

*The Mississippi Delta, home to 2.2 million, represents the worst-case scenario. It is sinking and losing wetlands faster than almost any place on earth and faces the most hurricanes annually. The record sea surge that prompted the Netherlands and Britain to erect barriers was 15 feet; Katrina's peaked at 28 feet.*

*Fundamental to the trouble is that for the past century the [Army] Corps [of Engineers], with the blessing of Congress, leveed the Mississippi River to prevent its annual floods so that farms and industries could expand along its banks. Yet the levees have starved the region of enormous quantities of sediment, nutrients and freshwater. Natural flooding at the river's mouth had also sent volumes of sediment west and east to a string of barrier islands that cut down surges and waves, rebuilding each year what regular ocean erosion had stolen. But because the mouth is now dredged for shipping lanes, the sediment simply streams out into the deep ocean, leaving the delta--and New Orleans within it--naked against the sea.*

*The Corps and industry also tore up the marsh by dredging hundreds of miles of channels so pipelines could be laid. Even bigger navigation channels were dug, and wave erosion from ships turned those cuts into gashes that allow hurricane-induced surges to race into the city. Similar practices are in play at many of the world's deltas, which could well benefit from plans such as those now being considered in Louisiana (Fischetti, 2006).*

### ***Natural disasters damage valuable ecosystems***

Ecosystems in disaster-prone areas are normally very resilient. Yet, extensive environmental degradation exposes ecosystems to greater damage in the face of a hurricane, tsunami, flood or other extreme events. This cycle of environmental degradation and disaster damage, will eventually destroy an ecosystem's capacity to

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provide critical productive services (such as arable land and potable water) and protective services (soil stabilization or coastal buffers).

Studies of the 2004 Indian Ocean tsunami impacts on coastal ecosystems indicate that where human settlements encroached on the coast, agricultural lands incurred significant damage due to water logging. In some areas the water never receded, while other areas experience continual water-logging since the tsunami. This has rendered the land uncultivable and forced many to find new livelihoods (DEWGA, 2008). Box 3 provides additional examples of the damage that natural disasters can wreak on ecosystems and the human-induced factors that have exacerbated the damage.

**Box 3. Sampling of disaster impacts on ecosystems and exacerbating factors**

<i>Disaster</i>	<i>Disaster Impacts on environment</i>	<i>Exacerbating factors</i>
<i>Earthquake</i>	Damage to industrial facilities resulting in toxic release. Building waste debris, and potential mix of hazardous materials	Topography and land cover Lack of building codes and urban planning / urbanization processes
<i>Flood, storms, cyclones</i>	Sewage overflow and chemical releases from roads, farms and factories; Ground and surface water contamination Loss of topsoil due to rapid drain of runoff.	Habitat and ecosystem destruction (e.g. coral reefs and mangroves) Deforestation and water siltation Urbanization and land use/land cover changes
<i>Droughts</i>	Habitat and crop destruction	Urbanization and unsustainable resource consumption Deforestation and land use/land cover changes
<i>Landslides</i>	Damage to habitat and land use functions, including agriculture Ground and surface water contamination	Deforestation and land-use/land cover changes

Source: Srinivas and Nakagawa, 2008

Natural disasters may also harm ecosystems indirectly. Damage to the built environment may result in the release and spread of debris and hazardous waste. Municipal wastes, blocking drains and canals, can cause floods, spreading disease and

exposing people and ecosystems to harmful materials. Damage to industrial facilities may release toxic substances, contaminating the air, soils and, water sources. This type of environmental damage can have serious short and long term effects on the health and livelihoods of affected communities.

Damage to already strained ecosystems further diminishes their capacity to provide resources critical to human life and livelihoods. This in turn hinders recovery and future development.

### ***Disaster response efforts negatively impact the environment***

In the aftermath of a disaster, the work of saving and rebuilding lives typically overshadows environmental concerns. However evidence from recent disasters shows that by failing to assess environmental impacts, relief and recovery initiatives often place further stress on weakened ecosystems, inadvertently creating new problems and increasing affected people's vulnerability to future disasters.

- ***Post disaster waste dumping*** in wetlands or poorly planned landfills has contaminated the soil and groundwater, affecting crop growth, fishing, and other provisioning services provided by the ecosystem.
- ***Unsustainable use of resources*** for housing and public infrastructure reconstruction has led to the destruction of forests, reefs and sand dunes that serve as protective buffers against landslides, storm surge and cyclones.
- ***Uninformed spatial planning*** for housing and public infrastructure reconstruction has led to the destruction of forests, reefs and sand dunes that serve as protective buffers against landslides, storm surge and cyclones.

Without sufficient attention to the environmental impacts of disaster recovery initiatives, efforts to rebuild lives and livelihoods may further damage ecosystems, thus increasing people's vulnerability rather than strengthening their resilience.

### ***Summing it up***

1. Humans rely on the productive services of ecosystems to sustain life and livelihoods. Poor and marginalized people often are more directly dependent on ecosystem services, in their immediate vicinity.
2. Environmental degradation diminishes an ecosystem's capacity to provide resources critical to human life and livelihoods and to rebound/recover after a change.
3. Environmental degradation leads to an increase in the frequency and intensity of natural disasters, and exacerbates the impacts of such disasters.

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4. Natural disasters severely hinder development, particularly in developing countries and amongst low income peoples.
5. Natural disasters weaken already strained ecosystems, thus decreasing the productive services upon which many rely for their livelihoods.

If we are to reduce our vulnerability to future disasters, improve our quality of life, and stop the cycle of environmental degradation, then disaster management policymakers and practitioners, in collaboration with affected communities, must ensure that all recovery initiatives serve to rehabilitate and strengthen the environment on which we depend.

# Environmental issues in recovery

## Introduction to key issues

Disaster management and environmental management, sharing many of the same concepts, issues, processes, and concerns, are inextricably linked. Good environmental management can lessen the frequency and impacts of a natural disaster. Conversely, poor environmental management weakens ecosystems, increasing the frequency of disasters and exacerbating disaster impacts. In a cyclical fashion, the shocks of sudden onset disasters or stresses of slow onset disasters further contribute to diminishing an ecosystem's resilience and capacity to meet human consumption needs. Therefore, considering natural disaster management within the larger scope of environmental management is essential if recovery efforts are to reduce the risk of future disasters.

Yet, funding for post-disaster environmental initiatives still largely focuses on the immediate impacts of disasters such as waste management and water quality issues. The lifestyle choices and livelihood practices that degrade ecosystems, making them more susceptible to damage and placing human interests at greater risk, too often receive little or no attention.

Nevertheless, a growing recognition of the direct relationships between environmental conditions, disasters, and development is leading to some new ways to address environmental issues in the disaster recovery process. Efforts are being made to take advantage of the window of opportunity presented by a disaster in order to reverse environmental degradation and reduce the disaster risk it poses.

The following sections are an attempt to illustrate some of these approaches by presenting experiences of previous recovery efforts and drawing lessons that may serve to inform those in the future. The content is categorized into several key issues and corresponding sub-issues, and the case studies and corresponding analysis are presented in boxes. This is not an exhaustive overview of the myriad linkages between disaster recovery and environmental management. Rather it is the first iteration of a larger attempt to collect and disseminate documented experiences in disaster recovery.

Drawing from reports, evaluations, research studies, and consultations, the following four key issues have been chosen for inclusion:

1. Dealing with debris
2. Implementing environmentally sound reconstruction
3. Promoting environmentally sustainable livelihoods
4. Rehabilitating ecosystems

These issues are not treated as mutually exclusive, but rather inter-related and often mutually reinforcing themes. Additional issues (such as the role of local communities and the recognition and application of indigenous knowledge and practice) will also emerge throughout the ensuing discussions.

## **Issue 1: Dealing with disaster debris**

The destruction caused by cyclones, tsunamis, floods and earthquakes can create enormous amounts of debris. The 2010 earthquake in Haiti toppled thousands of buildings, turning former houses, stores, offices, and factories into rubble. Disaster debris may include waste soils and sediments, vegetation (trees, limbs, shrubs), municipal solid waste (common household garbage, personal belongings), construction and demolition debris (building and their contents), vehicles (cars, trucks, boats), and white goods (refrigerators, freezers, air conditioners). The often vast amount of waste, not only impedes access to affected areas, but can propagate dangerous infectious diseases. Moreover, damage to industrial facilities, refineries, and sewer systems, can trigger secondary hazards, exposing the environment and survivors to toxic and flammable materials that may or may not be immediately discovered. In the face of such an immense task, waste management facilities, if they exist, are often quickly overwhelmed.

### ***Sub Issue 1: Potential environmental and health impacts of waste management activities***

Pressed to act quickly, methods of handling and disposing of waste are often adapted without consideration to the immediate and long term environmental impacts. Such impacts may include:

- *The contamination of ground water:* This may result from the leakage of petroleum products, carcinogens, and other harmful chemicals, which may not be easily removed or neutralized. Uncontrolled dumping, inappropriate landfill sites, or overburdening existing landfills increase the risk of contamination. Groundwater contamination can have long term and serious health impacts and may not be easily neutralized.
- *The weakening of important ecosystem services:* Dumping waste into water bodies can kill fish populations. Dumping debris into wetlands can inhibit their capacity to absorb and filter water and damage the protective services they provide against flooding and storm surge. Dumping wastes in agricultural fields (as happened in Banda Aceh after the Tsunami) result in land contamination.
- *The increase of water-borne diseases:* These may include typhoid, dysentery, cholera, respiratory infections and skin diseases. When bio-degradable wastes, such as sewerage, are not quickly removed, they can become the breeding ground for disease vectors, such as rats, mosquitoes and flies.

***Sub Issue 2: Challenges of managing post disaster waste***

Waste management has been consistently cited as a major weakness in responses to natural disasters. According to a UNEP assessment of post tsunami waste management practices:

*“Emergency efforts ... have resulted in haphazard disposal of rubble along roads, in open fields, into drainage ditches, low lying lands and waterways, including beaches. This is likely to cause long-term problems by clogging waterways and polluting beaches. Burning of debris is also evident in certain areas.”*

Following are a list of factors that have contributed to weak waste management efforts in prior post disaster initiatives.

- In some disaster affected areas, there may be no formalized waste management system. Public awareness raising campaigns can help to limit uncontrolled dumping while a waste management strategy is developed.
- Environmental standards may not be integrated into waste management processes. In such cases, national environmental agencies have provided guidance for waste management but integrating new policies and procedures in the aftermath of a disaster is typically unrealistic.
- Clearing and processing of wastes are not systematized, and done on an ad-hoc manner, losing opportunities for recycling/reusing the wastes, and creating jobs/income for affected populations.
- Overburdened pre-existing facilities often do not have access to the large machinery required to demolish and remove large-scale debris or the trucks to transport it.
- Most international humanitarian actors have little technical experience in waste management. Effective waste management plans can be developed in a timely fashion, but this requires the expertise of experienced disaster waste managers.

**Case 1: Coordination challenges and environmental impacts of post disaster waste management in Turkey**

On 17th of August 1999, an earthquake hit the Marmara Region in the north-western part of Turkey. The consequences of this earthquake were devastating - more than 15,000 people died, nearly 44,000 people were injured, and more than 120,000 people were left homeless. The earthquake affected an area up to 500 km from the fault which included industrial zones. The total amount of rubble generated in the Marmara region has been at estimated 13,180,000 tonnes.

Waste management operations were undertaken by local municipalities, who lacked the capacity to manage this level of waste. A Crisis Center (CC) was quickly established within the Ministry of Environment. Technical specialists were sent by the CC in order to

help local staff determine sites for the disposal of demolition waste and other environmental issues. Yet clear lines of authority and accountability were not determined, often resulting in confusion of roles and responsibilities.

During the first month after the earthquake, an emergency removal of the rubble was conducted and the search for people inside the damaged buildings continued. Furthermore, the waste was removed from roads and large areas to give access to vehicles.

The transportation of rubble from the demolition sites to the disposal sites was undertaken by a combination of public and private sector vehicles as municipalities were neither administratively prepared nor physically equipped to manage the waste transport. The private contractors operated in accordance with contracts with the relevant municipalities, but the overall effort lacked sufficient coordination, resulting in duplication of efforts and inefficient resource management.

Due to the logistical challenges, no sorting of the demolition wastes was performed and it was disposed of at 17 dump sites appointed by the Ministry of Environment (MoE). These sites were selected in compliance with Regulation of Solid Waste Management, which excluded the disposal of demolition waste to sea, river, river bed, lake and agricultural areas. The 17 dumpsites were utilized to capacity. Due to the overwhelming demand, municipalities were forced to identify additional sites that had not been environmentally assessed. Additionally, uncontrolled dumping occurred at illegal sites. This led to a number of issues:

- During the emergency response period, small quantities of rubble were illegally dumped on the coastline, creating potentially detrimental impacts on the coastal environment, as well as creating negative visual impacts.
- At many of these non-MoE approved sites, the waste was disposed of in an uncontrolled manner, being spread all over a very large area, constituting a detriment to the environment and hindering the subsequent collection/recycling of the waste.
- Certain dump sites lay in valleys which restricted the use of heavy machinery required to transport the waste.

The management of the disposal sites varied with some provinces using the waste as engineering fill for the construction of new villages and for land protection against occasional flooding of the river. However, for most provinces, the wastes disposed of following the earthquake were mixed with soil, carpets, clothes, wood and other materials, making it non-recyclable without lengthy and expensive pre-sorting. At the same time, the waste was normally disposed of at a location where it was almost impossible to collect. At two of the larger dumpsites, crushers were located as donated by the Swedish company Svedala. However due to a lack of training and assistance and insufficient capacity to effectively sort the waste, these crushers were not fully utilized.

Source: Emergency Planning for Disaster Waste: A Proposal based on the experience of the Marmara Earthquake in Turkey. Retrieved from <http://www.grif.umontreal.ca/pages/papers2004/Paper%20-%20Baycan%20F.pdf>

**Lesson 1:** Without a clear understanding of roles and responsibilities, the local municipalities, unprepared for such an enormous task, were forced to take a rather ad hoc approach to managing the waste.

**Lesson 2:** The pre-selection of waste disposal sites as part of a disaster contingency plan, can lessen the environmental and health impacts of ad hoc and uncontrolled dumping.

**Lesson 3:** Sorting waste at source/on-site in the earliest phases of the process can allow for the reuse of a large portion of the waste material. Once the debris has been dumped at disposal sites, sorting and recycling is an expensive and time-consuming process.

**Lesson 4:** Conducting an inventory of heavy equipment available locally that can be used in an emergency is one means of preparing for waste removal before a disaster happens. Estimating the kinds and volumes of wastes that can potentially be generated in a neighborhood will also help local governments more accurately design and coordinate waste removal efforts.

Since the 2004 tsunami, greater attention has been given to planning and implementing effective and environmentally sound waste management programs. The Government of Indonesia / UNDP Tsunami Recovery Waste Management Programme (TRWMP) is an example of a comprehensive and coordinated effort to minimize disaster waste disposal and its adverse impacts on valuable ecosystems, while strengthening the municipal waste management systems in 13 districts (UNDP, 2008). A strong commitment to the short and long term aspects of managing waste can accelerate recovery, reduce health risks, lessen reconstruction costs and prevent further degradation of essential natural resources.

**Box 4. Components of a waste management system**

**Collection:** The collection of waste typically happens in two stages following a disaster. The aim of the first stage is to eliminate or mitigate the threat of exposure to hazardous waste and clear debris that obstructs access to emergency areas. The purpose of the second stage is to clear the debris so as to facilitate reconstruction.

**Transport and storage:** Transporting immense amounts of waste of varying mass, size and composition can be a major logistical challenge (See Box 1). In some cases, waste is transported to transitional sites for storage if processing plants and/or disposal sites are unable to immediately accommodate the quantity of material.

**Processing:** Processing waste is an important step in reducing the environmental impact

of waste management systems. During the processing stage, waste is sorted into crushed stone, shredded wood or reconstructed brick, to be dealt with in different ways.

**Disposal:** Most commonly waste is either incinerated or dumped in a landfill. To maximize the storage capacity of a landfill, waste may be shredded, ground, compressed, or incinerated before dumping. Frequently, existing landfill capacity is insufficient, and new landfill sites must be assessed, identified and prepared (in some cases, temporary landfill sites may be used).

How these various components come together to form a waste management strategy depends on the quantity and composition of waste, the capacity and resources available, the level of urgency, and the extent of commitment to environmental protection.

### ***Sub Issue 3: Managing hazardous wastes***

The most urgent waste concern following a natural disaster is locating, containing and safely managing hazardous substances. Efforts to identify and control hazardous wastes commonly takes place during the emergency or relief phase, however exposure to hazardous substances can occur throughout recovery phase. One frequently cited example is the exposure and inhalation of asbestos from damaged buildings which can cause serious respiratory illnesses, including lung cancer. Commonly used as a building material, it can pose a health threat to those involved in sorting, recycling, and disposing of building debris.

Additionally, chemical spills may not always be immediately identified. This was the case during the Great Hanshin earthquake in Japan (See Case 2).

#### **Case 2: Chemical spills during the Great Hanshin earthquake in Japan**

Amongst the destruction following the 1995 Great Hanshin-Awaji Earthquake were chemical spills of chlorinated organic compounds, such as tetrachloroethylene, that are commonly used as cleaning agents. Tetrachloroethylene, being heavier than water, low in viscosity and volatile, easily infiltrates deep into the ground, contaminating the soil. It also pollutes subsurface air in this process, and the air comes up to the ground surface to cause serious health problems for people. The substance also goes down deeper to reach and contaminate ground water. The pollution then further spreads along with the flow of the ground water. At this point, it is much more difficult to filter out the contaminants.

A research group, from the Geological Society of Japan, conducted a geo-pollution investigation on chemical cleaners throughout Kobe city. According to the study, 55 of the 377 researched sites were found to have contaminated soil. In the worst case, the tetrachloroethylene concentration reached 3,900 times more than the environmental quality standards. In the Nada-ward to find a critical situation that 35 out of 60 cleaners were damaged by the disaster, including 11 that had caused

contamination (Tainosho et al, 1995). The tetrachloroethylene concentration exceeded acceptable standards at 90 ppm in three cases, including the highest with 200 ppm.

Without clear policies concerning soil contamination, reconstruction works had already been under way in the polluted areas leaving the contaminated soil as it was.

Source: Lessons from the Great Hanshin Earthquake, Retrieved from [http://www.shinsai.or.jp/hrc-e/publish/lessons\\_ghe/lghe19.html](http://www.shinsai.or.jp/hrc-e/publish/lessons_ghe/lghe19.html)

The United Nations Environmental Programme provides the following guidelines on managing hazardous substances:

- All sources of acute risk (such as chemical spills from damaged infrastructure) should be identified as early as possible.
- Special consideration should be paid to the potential issue of building rubble being contaminated by asbestos. A detailed survey should be undertaken by a suitably qualified expert, prior to handling and transporting building rubble.
- Access to affected sites/areas should be restricted until clean-up or risk reduction measures can be taken.
- Appropriate Personal Protective Equipment (PPE) should be used at all times by those individuals involved in assessment and clean-up activities.
- Plan the location of emergency waste disposal sites with local authorities to avoid potential contamination of water sources and the generation of disease vectors and odors.
- The burning of waste should, as far as is possible, be avoided due to the risk of inhalation of toxic fumes by residents and workers, particularly where plastics are being burned.
- Where burning is being considered a thorough risk assessment should be undertaken.
- Hazardous healthcare waste (HHCW) and other forms of hazardous waste should be disposed of using appropriate methods, such as steam sterilization (autoclaves) for HHCW.
- Where appropriate facilities are not locally available for the disposal of hazardous waste, such as chemicals and hydrocarbons, temporary storage facilities should be constructed and used until such time as appropriate long-term disposal solutions are identified (UNEP, 2010).

***Sub Issue 4: Recycling disaster waste***

In principle, 90% of demolition waste is recyclable if contaminants have been removed and the remaining waste is effectively sorted (Baycan, 2004). There is a significant range of uses for recycled waste materials.

- Biodegradable waste such as trees, vegetation etc. may be shredded or composted and reused as agricultural fertilizer.
- Steel, and other ferrous metals, can be immediately used for reconstruction projects. Additionally, ferrous metals are highly profitable recycled materials that can be salvaged and sold for re-melting.
- Wood can be used to rebuild new houses or retrofit damaged ones. Following the cyclone Orissa, fallen trees were used to build new boats for fishing communities. Processed wood can be used to create engineered building products or used as fuel. In Aceh, recycled wood was used to manufacture new furniture and waste wood in kilns to fire brick.
- Concrete and stone is often ground into aggregate and used as sub-base layers for roads, or as infill to raise houses above flood elevations, and for embankments and breakwaters.
- Collected dirt has been recycled to cover landfills or delivered to farmers for use as topsoil.

***Environmental benefits of recycling***

Recycling reduces further degradation of the natural environment. The reuse of existing materials decreases the overall volume of waste to be disposed. This translates to fewer landfill sites and less air pollution due to waste incineration. The use of recycled building materials lessens the often damaging environmental impact of extracting large amounts of raw/virgin materials, such as timber, sand, and stone, needed to rebuild damaged physical infrastructure.

***Financial benefits of recycling***

Additionally, there are many financial benefits to recycling. Waste processing projects can generate jobs - cash for work projects which focus on debris removal have been conducted extensively following earthquakes, tsunamis, and windstorms. The sale of salvaged materials can generate income for waste management projects and affected populations. Furthermore, recycling waste materials decreases the costs of disposing waste (e.g. development of landfill sites, transportation costs). Finally, by reusing disaster debris, reconstruction projects cut down costs of procuring and transporting building materials.

### ***Sorting waste***

In order to recycle waste effectively, it needs to be sorted based on the intended uses of the different materials. Collecting mixed debris may be the quickest way to clean up areas for reconstruction, but sorting debris at a later stage can be time consuming and work intensive; making it cost-prohibitive. China and Japan, following the respective 2008 Wenchuan and 1995 Great Hanshin-Awaji earthquakes, rapidly collected and removed the earthquake debris before sorting. Evaluations of the Japanese earthquake debris removal program note that while the demolition and removal of rubble was completed quickly, many salvageable building materials and components were demolished in the process (Disaster Reduction Learning Centre, 2008). Additionally, immediate removal before sorting also required significant space to temporarily store the waste as well as measures to prevent contamination of nearby water and food sources.

Some post disaster waste management projects have worked with communities to sort their waste at the collection point (See Case 3). This has allowed waste managers to redirect debris more efficiently for recycling and further processing.

#### **Case 3: Communities sort waste on site in Hawaii**

Hurricane Iniki struck the Hawaiian island of Kauai in September 1992. The storm generated more than 5 million cubic yards of debris—seven years' worth of Kauai's normal refuse—for a landfill with less than four years of remaining capacity. Kauai needed the four years to plan and design a new landfill, and shipping the debris off the island for disposal was not economically feasible. Island officials therefore chose to develop an efficient collection and recycling plan that saved both money and the dwindling landfill space.

Within days of the storm, island officials, with the cooperation of local landowners, established five temporary hurricane debris receiving sites. Officials trained temporary site operators to separate recoverable materials on site, but encountered many problems during the early stages of the cleanup effort. Hauling contracts had been written quickly and did not include incentives to keep materials free of contaminants. Consequently, some reusable materials became unusable. Haulers mixed clean loads of green waste with other trash and combined hazardous materials with recyclable debris. Stores and household refrigerators generated tons of food waste, which was mixed with recyclable materials. In the absence of instruction to do otherwise, residents began creating spontaneous dumps and at some sites burned or buried debris. In addition, the initial collection contractors were construction crews with little or no experience in handling and recovering solid waste.

Because Kauai is an island, officials could not easily spread the burden by transporting hurricane debris to unaffected communities. Without an adequate management plan, the collection sites were overwhelmed until December, when officials implemented a

debris management plan and contracted with professional solid waste personnel to manage the sites and the collection process. The island's solid waste management plan focused on recycling. From the beginning, local and state officials made a firm commitment to divert the massive amounts of debris from Kauai's landfill. A response team that included local, state, and federal government staff, contractors, and the county's solid waste consultants developed the plan. Team members agreed that materials recovery was the most environmentally sound and economical method of managing the hurricane debris.

The plan aimed to divert debris in a cost-effective manner by separating materials at the point of generation. It also proposed methods to maintain separation through the collection, transportation, storage, and processing stages. The plan required residents to separate materials into five piles at the curb: green waste; metals and appliances; wood debris; aggregate materials, including toilets, tile roofing, and concrete; and mixed debris. The plan also banned the burning of debris and instituted curbside collection across the island to accommodate those unable to haul the debris themselves. The plan ensured that processed debris was usable and met market specifications.

All of the metals, appliances, tires, and aggregate materials were reused. The aggregate was used to make revetment walls to shore up county shore-front property. A local company processed more than half of the 100,000 tons of green waste created by the storm into compost, thereby saving the county millions of dollars and precious landfill space. As a result of delays, the recycling plans for the remainder of the green waste and mixed debris fell through, and the waste was buried or land-filled. In addition, the plan instituted specific controls at collection sites across the island to monitor incoming debris, contain odors, and minimize water runoff.

One of the first orders of business after the storm was to inform residents about what to do with hurricane debris scattered across their property. With all communication systems down for several weeks, however, it was nearly impossible to reach all island residents to instruct them on how to separate materials. Kauai had only a fledgling recycling program, and source separation was not a household practice. As the communication systems recovered, island officials posted signs, ran articles in the newspaper, and broadcast radio announcements to inform citizens of upcoming collection efforts. After several weeks of intense outreach, the public caught on and began separating materials before pickup or drop-off. Discrete piles of green waste, metals, wood, and mixed debris soon lined the streets of Kauai.

Source: Planning for Disaster Debris, accessed at <http://www.recycledddebris.com/rCDd/Resources/Documents/CSNPlanningDisasterDebris.pdf>

**Lesson 1:** The engagement of communities to sort the waste at the source (or on-site), allowed waste managers to quickly redirect materials for appropriate recycling or disposal. This also greatly reduced the total amount of waste disposed in

landfills.

**Lesson 2:** Taking the time to develop a sound waste management plan enabled the waste management program to more effectively sort and recycle debris. This minimized environmental impacts, reduced waste management costs, and significantly shortened the duration of the cleanup effort.

**Lesson 3:** By developing a clearly defined organizational structure and public information materials, recovery agencies can engage communities to play an important role in streamlining and expediting cleanup efforts in the chaotic aftermath of a disaster.

### ***Recycling waste on site***

Post disaster recycling often takes place immediately at the disaster site. In addition to salvaging personal valuables from disaster wreckage, many affected households have salvaged valuable building materials such as doors, window frames, bricks and usable timber. Of such value are these reusable materials, that in the wake of the 2005 Kashmir earthquake many families in transitional shelters left members behind to guard their damaged and destroyed homes. Government assistance in salvaging valuable materials has provided homeowners in Pakistan with additional material for rebuilding and a potential income through the sale of steel and other valuable products (See Case 4). Where reconstruction assistance is unavailable to homeowners, good on-site recycling is even more critical to alleviate the costs of rebuilding.

With respect to waste management operations, recycling materials at the collection point greatly reduces the overall amount of waste to be transported and processed.

#### **Case 4: Homeowners salvage and sell debris in Pakistan**

In the aftermath of the Earthquake that shook Pakistan in 2005, the Earthquake Reconstruction and Rehabilitation Authority (ERRA) in partnership with NATO, US Army Engineers, the AJK Public Works Department, and the Municipal Corporation of Muzaffarabad (MCM) commenced the herculean task of cleaning up the city of Muzaffarabad.

The city spans the valleys of the Jhelam and Neelum rivers. Any irresponsible dumping leads to polluting the two rivers and threatens the health of the communities living downstream. Silting of the river also poses a threat to Mangla Dam located downstream. From the very beginning, the ERRA has tried to guard against dumping sites emerging here and there haphazardly. While all earlier dumping was done at a site called Makri (now turned into a park), a new dumping site has been developed on the banks of the Neelum river.

After early initiatives to clear major roads for emergency access and eliminate any debris-related environmental or health threats, the project commenced with the

immense task of removing the debris, to expedite the reconstruction of the city.

Contractors were hired to collect and transport the debris. Contractors usually agreed to pay a pre-determined fee to the homeowner. This allowed them to remove the rebar and anything else that was deemed valuable including fixtures, wood, pipes, doors, wires, etc. These things were sold in the open market to middlemen specialising in various materials. The steel, by far the most valuable part of the house, could be sold several times over to brokers and middlemen before it ended up at a mill for re-melting.

Noting that middlemen were taking a large percentage of the profit, the MCM adopted procedures that pay extreme care to people's rights over property and their sensitivities to what were their homes before the earthquake. The MCM engaged homeowners in identifying, salvaging and recycling materials that they deemed valuable. This allowed homeowners to recycle materials for the reconstruction of their homes and sell valuable salvage materials, particularly rebar, without going through a middleman. The contractors, on their part, are required to carry out their activities with extreme care so that all reusable material could be retrieved and given back to the owner.

An estimated 20% of a demolished house was returned to the owner for reuse. Homeowners reported that the money from rebar sales was used to start building a new house, pay off debts accumulated during the months since the earthquake, or help with continuing expenses. Many immediately pitched tents on the cleared lot and started rebuilding.

Of the 80% collected, a large part of the rubble was recycled and reused for building blocks and other building materials. For this purpose, the MCM received a rubble recycling plant, possible through a donation by the Belgian government, to transform the rubble into useful materials for reconstruction. Once completed the dump site will be covered and serve as a recreational area.

Source: ERRA, Moving Mountains, accessed at <http://www.erra.pk/Reports/KMC/CaseStudies/Environment.pdf>

**Lesson 1:** By salvaging and recycling valuable building materials, homeowners were able to earn additional income to begin reconstructing their homes.

**Lesson 2:** Recycling debris saves builders from further exploiting the environment to extract needed building materials. In the case of Pakistan, the extraction of building materials had caused past landslides in the region.

**Lesson 3:** On-going dialogue, networking and planning with recyclers and heavy equipment owners is key to ensuring that all benefit equitably.

***Sub Issue 5: Creating employment opportunities***

The immense task of disaster waste management can create temporary, and to a lesser extent, long term, livelihood opportunities. Through cash for work programs and direct employment, governments and partners have engaged thousands of people in the removal and processing of disaster debris. These labor intensive employment schemes have not only facilitated the cleanup process, but have provided individuals with much-needed incomes to meet basic needs and begin reestablishing their livelihoods.

Close supervision and training of workers by experienced waste managers is advisable to protect workers from exposure to hazardous substances and unsafe structures.

**Case 5: Creating livelihood opportunities in Aceh and Nias through a waste management programme**

In January 2005, the Tsunami Recovery Waste Management Programme (TRWMP) was conceived to provide a coordinated, pragmatic response to the public health and environmental concerns associated with tsunami/earthquake debris and municipal solid waste management following the 2004 earthquake and tsunami. TRWMP was implemented in Aceh through UNDP's Emergency Response and Transitional Recovery (ERTR) Programme, in partnership with the Rehabilitation and Reconstruction Agency (BRR) and thirteen local government sanitation departments in thirteen districts.

TRWMP's initial aims included:

1. Debris clearance;
2. Restarting essential solid waste management services;
3. Creating immediate temporary employment; and
4. Recovery of recyclable materials for use in reconstruction.

Once completed, the programme focused on the following longer-term goals:

1. Strengthening the capacity of local government to conduct effective and efficient collection, recovery and disposal of municipal and tsunami waste;
2. Rehabilitation of critical waste management infrastructure;
3. Supporting local enterprises in the creation of livelihoods opportunities in recovery, processing and recycling of waste; and
4. Clearance and rehabilitation of tsunami- impacted agricultural land.

Of particular interest is the Waste Management Livelihoods project that commenced in May 2007 to create and/or strengthen private sector Small and Medium-Sized Enterprises (SMEs) in waste-related businesses. This includes collection and processing of recyclable waste, which creates income and reduces waste going into landfills. The Waste Management Livelihood projects now supports 10 NGOs, 12 CBOs and 120 SMEs in a wide range of activities including composting, mushroom production, collection, sorting and transport of recyclables including plastics, metal, glass and paper, processing of recyclable material and organic detergents, and small scale bio-gas from waste

production. As of August 2008, there were 1,829 direct (entire livelihood) beneficiaries, and 6,664 indirect (partial income) beneficiaries. In addition to the distribution of working equipment, small grants are also being distributed, now totaling IDR 1.3 billion.

TRWMP livelihoods projects have been supported in Kota Banda Aceh, Aceh Barat and Pidie which have focused on re-use and recovery of valuable materials from amongst the tsunami waste. For example temporary workers have been allowed to share revenues derived from the sale of immediately useful materials (metals and plastics). This has provided an additional incentive over and above the Cash for Work (CfW) wages. In other instances, materials not immediately salable (wood, stone, and concrete) have been used to assist small businesses to recover from the tsunami (e.g. provision of timber to brick kilns), have been provided to NGOs to support their reconstruction efforts, or are being used to rehabilitate infrastructure (e.g. in the construction of a road to Ulee Lhee Port).

A flagship project of the livelihoods/waste management programme has been the construction of a furniture workshop at Gampong Jawa landfill site in Kota Banda Aceh. At the workshop, recovered tsunami wood (of which approximately 20% is high quality hardwood), is sawn and planed into useable timber, which is then used for furniture making. As of November 2008, 40 skilled labourers were employed at the furniture workshop making chairs, tables, cupboards and beds. Through partnerships with UN agencies and NGOs, the furniture shop has constructed chairs and desks for newly-rebuilt schools. Revenue from sales is put into a separate bank account and funds are channeled back into TRWMP projects. On completion of the TRWMP, the workshops will be turned over to employees to run as cooperatives.

Sources: UNDP Indonesia TRWMP Project Facts November 2008, accessed at <http://www.undp.or.id/factsheets/2008/ACEH%20Tsunami%20Recovery%20Waste%20Management.pdf>

Multi donor fund Aceh and Nias Progress Report December 2007, accessed at <http://siteresources.worldbank.org/INTINDONESIA/Resources/226271-1176706430507/3681211-1194602678235/4375533-1198637122429/MDF3years.pdf>

**Lesson 1:** The extensive work of clearing debris has increasingly served as an opportunity to provide temporary employment to affected populations. Cash-for-work programs, in which individuals are paid to clear debris, engages people in the process of rebuilding their lives, while providing critical assistance to meet basic needs and rebuild livelihood assets.

**Lesson 2:** A large extent of disaster debris can often be reused. In addition to the utility of recycled or salvaged materials for housing and public infrastructure projects, disaster debris, such as wood and metal can serve as raw material to help reestablish the businesses of skilled trades-people.

**Lesson 3:** The entrepreneurial approach, of identifying every opportunity to contribute to recovery, can turn a task such as waste management into a driver of

longer term recovery operations.

**Lesson 4:** Designing innovative building materials and components from debris (example, rubble mixed with concrete to form building blocks) often creates multiple benefits – jobs, income, reconstruction and recovery.

**Box 5. Considerations for developing a post-disaster waste management system**

The best waste management strategies are designed prior to a disaster in which contingency plans have been developed to meet the increased demand on existing systems. When such plans do not exist or the existing capacity is overwhelmed, a rapid assessment and thorough adaptive planning and monitoring will be required. Several key considerations for planning have been identified in prior post-disaster waste management initiatives (Karunasena et al, 2009).

- The existing policies and regulatory mechanisms related to waste management and environmental conservation.
- The capacity of local areas to handle waste, including number and types of trucks, condition of disposal sites and opportunities and capacity to recycle.
- The quantity of waste generated including composition and source.
- The potential environmental impacts of different disposal methods.
- The means of communicating waste management processes to affected populations.
- The opportunities for employment through clean up works.
- The scope of reconstruction works expected - in order to identify future waste streams and opportunities to use recycled building waste.
- Designation of temporary dump sites for future disasters
- Estimation of wastes that may be generated during a disaster, both household and C&D wastes.
- Development of community guidelines for sorting disaster wastes in-site.

For further reading on post disaster waste management please see:

*Haiti Earthquake Reconstruction: Knowledge Notes from DRM Global Expert Team for the Government of Haiti*

[http://www.gfdr.org/gfdr/sites/gfdr.org/files/publication/GFDRR\\_Haiti\\_Reconstruction\\_KnowledgeNotes.pdf](http://www.gfdr.org/gfdr/sites/gfdr.org/files/publication/GFDRR_Haiti_Reconstruction_KnowledgeNotes.pdf)

*Post disaster waste management strategies in developing countries: Case of Sri Lanka*

<http://www.allbusiness.com/science-technology/earth-atmospheric-science-meteorology/12362084-1.html>

*Planning for disaster debris management*

[http://ir.canterbury.ac.nz/bitstream/10092/3669/1/12621629\\_WasteMINZ\\_final.pdf](http://ir.canterbury.ac.nz/bitstream/10092/3669/1/12621629_WasteMINZ_final.pdf)

*Emergency Sanitation: Assessment and Programme Design*

[http://www.sheltercentre.org/sites/default/files/Emergency%20Sanitation%20\(WEDC\).pdf](http://www.sheltercentre.org/sites/default/files/Emergency%20Sanitation%20(WEDC).pdf)

*Safer Homes, Stronger Communities – Chapter 9: Environmental Planning*

<http://www.housingreconstruction.org/housing/Chapter9>

*Asbestos: hazards and safe practices for cleaning up after the earthquake*

<http://www.who.int/hac/crises/chn/asbestos/en/index.html>

*Planning for disaster debris*

<http://www.epa.gov/osw/conservation/rrr/imr/cdm/pubs/disaster.htm>

*Hurricane Katrina Disaster Debris Management: Lessons Learned from State and Local Governments*

[http://www.swana.org/pdf/swana\\_pdf\\_358.pdf](http://www.swana.org/pdf/swana_pdf_358.pdf)

*Moving Mountains: The Story of Debris Removal from the Earthquake-hit City of Muzaffarabad, Pakistan*

<http://www.erra.pk/Reports/KMC/CaseStudies/Environment.pdf>

*Waste management following Asian tsunami earthquake – Key issues*

<http://www.who.or.id/eng/contents/aceh/wsh/WMinE%20Tsunami%20Emergency%20Waste%20Action%20Planning%204th%20Jan.pdf>

*Environmental Management and Disaster Preparedness: Lessons Learnt from the Tokage Typhoon (Typhoon 23 of 2004) in Japan*

<http://www.unep.or.jp/ietc/wcdr/unep-tokage-report.pdf>

*Addressing Disaster Waste Management Issues on Turks and Caicos Islands*

<http://www.unep.org/greenstar//publications/Report%20TCI%20-%20Addressing%20Disaster%20Waste%20Management%20Issues,%20Nov%202008%5B1%5D.pdf>

## Issue 2: Implementing environmentally sound reconstruction

The damages, losses, and needs assessment of the 2010 Haitian Earthquake, reported that 105,000 homes had been completely destroyed and more than 208,000 damaged; 1,300 educational establishments and over 50 hospitals and health centers had collapsed or were unusable; and most of the Ministry and public administration buildings had been destroyed (Government of Haiti, 2010). In such post-disaster situations, the massive reconstruction process can have serious environmental impacts causing further degradation of critical ecosystem services and exposing populations to new or increased risks.

### *Sub Issue 1: Site selection*

When environmental impact assessments of potential reconstruction sites have not been conducted, disaster affected populations have been exposed to additional health and natural hazards. In the rush to provide transitional shelter to the thousands of homeless of Sri Lanka and southern India following the 2004 tsunami, authorities chose low-lying sites that later flooded during the monsoons (Vivekanandan, 2005). In Indonesia, permanent housing settlements were developed in flood plains and barricaded from the ocean by a sea wall that blocked the surface flow of water and regularly flooded the entire settlement (WWF, 2009). The expansion of infrastructure, including bridges, railway lines and roads, has created a barrier across settled valleys in Vietnam and India preventing excess rainfall from escaping and increasing the severity of floods (Benson et al., 2006).

Site selection and urban planning/zoning in general is a complex process, in which technical, social, political, and economic factors also must be considered. In the post-disaster setting the urgency to rebuild compounds the challenge of choosing appropriate sites. With little time for widespread consultation and negotiation, significant compromises are often made. Due to a lack of awareness and the often time-consuming process of conducting environmental impact assessments, environmental considerations are frequently forfeit in the decision-making process. However, new tools have been developed to streamline the assessment process, making it much less of an obstacle to initiating a quick and early reconstruction (See Case 6).

#### Case 6: Fast track environmental assessment tool in Aceh

More than 100,000 homes, public buildings, and roads were destroyed in Aceh by the tsunami of December 26, 2004. Some half a million people were suddenly left homeless, and were housed in hastily-built barracks and tents or squeezed into schools and mosques. In order to help those affected build a roof over their heads as soon as possible, hundreds of Indonesian and international aid organizations made project applications to the provincial government.

The environmental control authority of Aceh province (BAPEDAL) ultimately selected 86

major projects to be examined for their environmental impact. However, to meet the urgent needs of the situation, a shortened and ‘easy to read’ version of the otherwise exhaustive test procedure had to be found. With this in mind, the GTZ-supported project “Support for Local Governance for Sustainable Reconstruction” (SLGSR) – financed by the German Federal Ministry for Economic Cooperation and Development (BMZ) – developed a method that focused on key environmental factors. This enabled a quick reaction to the people’s need for reconstruction, while keeping the negative effects on the environment to a minimum.

The task was challenging, particularly as the construction of a road or canal is governed by different criteria from those for building a house. So the selection of key projects – reached by SLGSR workers in conjunction with the provincial environment authority – was of great importance. In some cases, the choice was easy. For example, in the quarrying of sand and gravel – both are taken chiefly from rivers near the building site. But if there are no controls on their removal, the course of rivers can be altered. That in turn can cause flooding and landslides. If a river changes course, it can even undermine bridge supports and make the entire structure collapse – something that occurred in two cases in the district of Aceh Besar, where there had previously been no controls. So it was obvious that all projects for the quarrying of sand and gravel would have to be carefully checked. Other major project types selected were for the building of roads, ports, airports, water systems, power stations, and waste disposal sites. The SLGSR team also developed a checklist for all building projects that did not have to undergo a compulsory review by the authorities. Using this list, those commissioning a project were able to check the most important factors themselves. The goal was to make those responsible aware of possible damage to the environment, while offering possible solutions.

The Indonesian environment ministry quickly agreed to the fast-track assessment method and gave its backing to the project-run courses to train the responsible officials in its application. But most of the local institutions still preferred the lengthy process they were familiar with. Many of the authorities did not adopt the fast-track method until November 2007, when the Ministry declared it to be the legal standard across the country in cases of reconstruction.

In the meantime, SLGSR workers and the provincial government had already tested the method on a new waste disposal site near the village of Makmur. The location was chosen as it did not threaten any key ecosystems and it contained large, impervious layers of clay (to prevent toxins from seeping deeper into the ground). The fast-track method cut the assessment time in half. When all the formalities had been dealt with, SLGSR workers and the environmental authority organized a public consultation with the nearby village community with nearly 300 people attending, to ensure public agreement before developing the waste site. The project included an improved sanitation system for the local communities and the prospect of new jobs.

Source: GTZ – Eight Case Studies from Aceh accessed at <http://www2.gtz.de/dokumente/bib/gtz2009-0112en-arpp-8-case-studies.pdf>

**Lesson 1:** It took two years from the day the decision was made to develop a fast-track environmental impact assessment. By then, reconstruction work in Aceh had already progressed so far that the new method was only of use for some of the projects. Identifying or developing such a tool prior to a disaster, can expedite environmental assessments; speeding up recovery efforts while protecting important ecosystems.

**Lesson 2:** Through analysis of existing data on ecosystems in the affected areas, certain locations may be identified where valuable ecosystems would not be endangered by reconstruction projects. In such cases a full environmental assessment could be waived, thus speeding up the process. However, consideration must also be given to the type of reconstruction project before waiving a full environmental assessment. For example, the potential impacts of a new waste disposal site on an ecosystem may be much greater than rebuilding a small group of homes.

**Lesson 3:** Broad capacity building and training for all development-related staff can help local and government officials to adapt to the specific needs of the post-disaster environment.

*For further information on environmental assessment tools, see Annex 1.*

### ***Sub Issue 2: Local procurement of building materials***

Local sourcing of reconstruction materials has almost become a mantra for many governments and other actors managing the recovery process. The use of local materials immediately creates jobs and injects cash into disrupted economies. Local materials can be acquired quickly and cheaply, without the logistic and administrative challenges that come with importing large amounts of goods. However, these benefits, combined with the urgency to begin rebuilding, commonly overshadow the damaging consequences of massive resource extraction.

The extraction of raw materials to meet the heightened demand of reconstruction can strain ecosystems, sometimes beyond their capacity to recover. When ecosystem damage reaches a critical point, the protection the ecosystem provides (via forests, sand dunes, reefs, and river banks) quickly diminishes. Developers in the earthquake prone city of Santa Tecla, El Salvador had been felling timber and mining raw materials from the foot of a ridgeline on the city's edge. By destabilizing the slope, the 2001 earthquake triggered a mudslide that buried over 500 people and as many houses (BBC, 2001). Not only can extensive resource extraction pose new disaster threats, but the resulting erosion of soil and decreased biodiversity can threaten the livelihoods of those who rely on natural resources for income generation.

### Case 7: Raw material extraction for post tsunami reconstruction in Indonesia

The Indonesian post tsunami master plan for Aceh and Nias included the construction of approximately 123,000 houses. The high demand for construction materials (sand, stone, timber and brick) led to intensified logging and sand/rock mining activities throughout Aceh and Nias.

Prior law limited the amount of timber which could be cut from the island forests, but illegal logging had been an ongoing problem when the tsunami devastated the islands. The BRR had provided a list of registered timber suppliers to 290 NGOs and donor organizations managing over 800 reconstruction projects, but it was the responsibility of each organization to make sure that the timber purchased was not illegally logged. Due to the inherent difficulties of ensuring that timber was legally sourced and the urgency to begin construction, many of the NGOs chose to trust their contractors. After a few of the major INGOs were found procuring timber from illegal sources, the provincial government, in June 2007, announced a complete moratorium on timber harvesting in Aceh. At the time, reconstruction works, mainly in the coastal areas, in Aceh had already used an estimated 850,000 cubic meters of illegal logs for building and fuel wood (Roseberry, 2009).

A seemingly less damaging alternative was to build with clay brick. However, evaluations found that amongst the 1,412 small brick-making businesses in Aceh, most were using very basic wood-fired kiln systems that were neither energy efficient nor capable of producing high quality brick. Because the kilns required so much fuel wood, the use of brick for wall construction was estimated to consume 2.5 times more timber than would the direct use of timber to build these same walls (ADB, 2006). To meet the need for fuel wood for brick making alone, about 10,000 hectares of forest would have to be logged.

In addition to the problem of sourcing wood products, the need for sand and stone has also had damaging environmental impacts. Gravel and sand were mainly extracted from riverbeds, particularly along the Aceh River, with a clear focus on Aceh Besar District (Supangkat & Hendratno, 2006). After the tsunami, the number of licensed sand and gravel quarries greatly increased (Krist, 2006). It is assumed that there is also a significant amount of illegal extraction, but the actual magnitude of the problem is not known. Many argue that the flooding that has beset many coastal communities since the tsunami is a result of over-extraction of river bed materials, downstream siltation at the river's mouth, and over-harvesting of timber from forests that historically mediated seasonal water discharge (Roseberry, 2009).

In order to reduce illegal deforestation, many I/NGOs turned to alternative means of more sustainable building material procurement, through the:

- Import of timber from sustainable sources in New Zealand and Canada.
- Import of pre-fabricated houses from external sources.

- New housing designs that specified reduced usage of timber products in place of materials such as bamboo.

Although these approaches were environmentally sustainable, they also posed several challenges, such as: an increased cost of materials and transport as well as lengthy transportation times. Experiments with alternative materials such as bamboo were generally not well accepted by communities.

Sources: Accelerating livelihood and environmental recovery in Aceh and Nias through tree crops, Retrieved from: <http://www.worldagroforestrycentre.org/sea/Publications/files/paper/PP0276-09.PDF>

A Balancing Act: An assessment of the environmental sustainability of permanent housing constructed by international community in post-disaster Aceh, Retrieved from <http://www.resorgs.org.nz/irec2008/Papers/Roseberry.pdf>

Environment and Reconstruction in Aceh: Two years after the tsunami, Retrieved from [http://postconflict.unep.ch/publications/dmb\\_aceh.pdf](http://postconflict.unep.ch/publications/dmb_aceh.pdf)

**Lesson 1:** Where extensive amount of damage has occurred, determining appropriate procurement methods will necessitate trade-offs with respect to time, cost, environmental impact, and social feasibility. Thus, it is important that priorities are established at the outset and clearly understood by everyone involved.

**Lesson 2:** Innovative alternatives in building design and building materials design can reduce the overall environmental impact. An ADB report noted that a combination of timber and brick or the use of hollow concrete blocks could greatly reduce the amount of timber required.

**Lesson 3:** Capacity building of materials suppliers through training and improved production equipment (such as more energy efficient kilns) could potentially diminish the overall environmental impact.

**Lesson 4:** Policy and regulatory frameworks, enforcing stricter environmental standards for suppliers could encourage more sustainable extraction and processing of local materials.

**Lesson 5:** By coordinating material needs across projects, external purchases can be combined, reducing both cost and transport time. However, this requires significant organization amongst implementers, many of whom take very different approaches to the housing reconstruction process.

***Sub Issue 3: Alternative building materials and technologies***

Although rarely initiated by governments, some reconstruction initiatives have attempted to use alternative building materials and technologies that reduce environmental impacts. These approaches may include:

- The use of recycled materials or non-traditional, yet abundant natural resources (e.g. bamboo)
- The development of environmentally-friendly methods to produce building materials (e.g. improved brick kiln designs)
- The adaptation of designs that minimize environmental damage (e.g. solar-generated electricity, communal sanitation systems)

In addition to their environmental benefits, many alternative approaches have also proven to be cost-effective, simple to adapt, and have resulted in more disaster resistant structures. The use of eco-materials for housing reconstruction in Cuba, described in Case 8, is an excellent demonstration of building technologies that can be locally produced/procured and are easily used and maintained.

**Case 8: Rebuilding to scale with 'eco-materials' in Cuba**

In 2008, Cuba was battered by two devastating hurricanes - Ike and Gustav – and a lesser one, Paloma. It was the only time that three major hurricanes have hit Cuba in the same season, with just a 10 day gap between Gustav and Ike. The hurricanes damaged over 84% of the houses in the affected areas, an estimated USD 10 billion in damage.

The *Centro de Investigación de Estructuras y Materiales* (CIDEM), a research think-tank at the Universidad Central de Las Villas, has worked with the National Housing Institute (NHI) and local governments to develop an affordable, environmentally sustainable, and disaster resistant approach to housing reconstruction.

The initiative is based on CIDEM's development of 'eco-materials' – building materials made with low embodied energy, often through recycling wastes. CIDEM developed a product called lime-pozzolana cement (CP40) made with recycled wastes from the sugar industry. This material is easy to make and can replace up to 40% of the regular cement in hollow concrete blocks without affecting the quality. Using CP40 and other similar technologies; bricks, concrete blocks, cement, roofing tiles, and bamboo furniture can be produced inexpensively on site using local resources.

In partnership with municipalities, who manage the entire process, CIDEM sets up simple workshops and trains workers in affected rural and urban neighborhoods. Typically within a week, the workshops begin operations, producing up to 1200 blocks per day – the equivalent of one house. Equipment is simple, consisting of easy-to-use machines ranging from hand-cranked presses that make mud and clay bricks, to vibrating presses for concrete brick making. During the first year of operation, CIDEM makes regular visits to new workshops to provide training and support and ensure that the production

complied with existing quality standards. After one year, the visits became less regular, as local partners acquire the needed skills and workshops become self-sufficient.

The inexpensive bricks are then sold to homeowners, who also receive training in homebuilding. The municipalities co-operate with local banks to finance house owners willing to invest in reconstruction and repair using materials from these local workshops. The banks offer special loans, favoring families with very low income, who otherwise have no means of purchasing building materials. More than 30 per cent of the project's beneficiaries are single mothers.

In some cases, residents have organised themselves into formal mutual-help brigades to build, repair or renovate their homes. This process has strengthened social networks and resulted in innovative ways of cooperation between neighbours, and helped to create additional job opportunities in the informal sector. The government also pays professional builders to supervise and assist homeowners in constructing their new houses.

An estimated 7,300 houses nationwide have been built or renovated using eco-materials. To stay prepared for future natural disasters that destroy or damage homes, some municipalities have established strategic reserves of micro-concrete roofing tiles. The lightweight but strong tiles can be used to quickly erect a small module home, and then the home can be expanded and built on as resources and time allow.

The use of eco-materials and the decentralized management model have spread beyond the context of post disaster reconstruction. Due to the success of its implementation and the wide acceptance by communities, municipalities have incorporated it into their own local strategies for development.

CIDEM collaborates with universities around the world and has 19 workshops employing over 200 people in Cuba. The approach has also been disseminated and transferred outside Cuba through the EcoSur network. Eco-materials workshops were set into operation in Nicaragua and Honduras. The governor of Morelia, Mexico, in 2005 placed an order for 14 workshops to be set into operation throughout the state. Additional workshops are currently in operation in Colombia, Ecuador, Guatemala, Honduras, Mexico, Nicaragua, Bangladesh, Nigeria, Mozambique and Yemen.

CIDEM works with the Ecosur initiative and all the machines and advice on how to use them is available from the Ecosur website ([www.ecosur.org](http://www.ecosur.org)).

Sources: World Habitat Awards, Retrieved from <http://www.worldhabitatawards.org/winners-and-finalists/project-details.cfm?lang=00=986C2BBF-15C5-F4C0-99A7AA69AEC53694>

UNDP Development Solutions newsletter, Retrieved from <http://ssc.undp.org/February-2009.232.0.html>

CNN, accessed at <http://edition.cnn.com/2010/WORLD/americas/04/09/eco.cuba.homes/index.html>

**Lesson 1:** The fact that the materials are produced locally diminishes a major part of the transportation costs associated with conveying the products from distant places, thereby contributing to savings of energy and fuel.

**Lesson 2:** The recycling of potentially hazardous waste materials (rendering them harmless to humans) to manufacture building materials presents a viable alternative to protect the environment and make agro-industrial processes more sustainable.

**Lesson 3:** Coordination with a broad spectrum of actors is crucial to implementation, social acceptance and scaling up of technology-based projects to national level. Providing appropriate financial resources through loan schemes is particularly important for low-income populations.

**Lesson 4:** Management of the projects by local governments can ensure that environmental benefits extend beyond the disaster reconstruction phase and become integrated in development planning.

It is imperative to note that the reconstruction of houses and physical infrastructure is not solely a technical endeavor. Social acceptability and economic affordability are equally important since the poor often build their own homes. Studies on construction in Africa have consistently found that innovative building technologies, when externally driven, have most often resulted in higher costs and poor sustainability. Without local buy-in, these buildings have often gone unused or unmaintained and quickly replaced with more socially accepted structures. Construction initiatives that learn from and build upon existing local practice and knowledge have met with much greater success, particularly when local communities have been involved in the design, planning, construction, and maintenance (Theunynck, 2003).

**NOTE:** Environmental degradation may often begin in the relief phase if not considered. The urgency to provide services and supplies often overshadows the corresponding environmental costs. Recognizing this, the Netherlands Red Cross and the Institute for Environmental Security are working to integrate more sustainable energy products and services in their “emergency response packages”, such as making use of renewable energy technologies instead of diesel generators. For more on this initiative, please see <http://www.envirosecurity.org/fuel/>.

#### ***Sub Issue 4: Strategic environmental and social framework***

Developing a strategic environmental and social framework can provide critical guidance and harmonize the efforts of all recovery actors. A strategic environmental and social framework is a set of policies, structures and operational guidelines which ensure that environment is properly considered throughout the complete reconstruction programme and project cycle – from policy development to planning, implementation,

monitoring, and compliance promotion. Following the 2004 East Indian tsunami, the Indonesian government developed the Strategic Environmental Framework (SEF) whose objectives included supporting environmentally and socially sound investments; ensuring that environmental and social aspects, including cumulative impacts, are considered at an early stage in the reconstruction planning process; and preventing inadequate implementation of environmentally sound plans and projects. The SEF is designed to assist decision-making in the project cycle's early stages and to provide a practical tool for mitigating project impacts. The framework proposes a series of interventions that can be used independently or as a whole.

Similar frameworks have been created in India following the 2004 tsunami, in China following the 2008 Wenchuan earthquake and in Haiti after the 2010 earthquake. Examples of such frameworks can be accessed at:

*Environmental and Social Management Framework- Indian state governments of Pondicherry and Tamil Nadu*

<http://www.pon.nic.in/tsunami/esmf.pdf>

*Environmental and Social Safeguards Screening and Assessment Framework (ESSAF)-Government of China*

[www.sc.gov.cn/zwqk/qgqs/js/200912/P020091208339336834603.doc](http://www.sc.gov.cn/zwqk/qgqs/js/200912/P020091208339336834603.doc)

For further reading on environmentally friendly post disaster reconstruction please see:

*Post-disaster housing reconstruction: Current trends and sustainable alternatives for tsunami-affected communities in coastal Tamil Nadu*

<http://www.isaac.supsi.ch/isaac/Gestione%20edifici/Informazione/post-disaster%20housing%20reconstruction.pdf>

*Safer Homes, Stronger Communities*

<http://www.housingreconstruction.org/housing/>

*Environment and Reconstruction in Aceh: Two years after the tsunami*

[http://postconflict.unep.ch/publications/dmb\\_aceh.pdf](http://postconflict.unep.ch/publications/dmb_aceh.pdf)

*After the Tsunami: Sustainable building guidelines for South-East Asia*

[http://postconflict.unep.ch/publications/dmb\\_bb\\_tsunami.pdf](http://postconflict.unep.ch/publications/dmb_bb_tsunami.pdf)

*Supply chain analysis and the sustainability of post disaster construction*

<http://www.grif.umontreal.ca/pages/conferencegrif08/41-Zuo%20et%20al.pdf>

*Technology, post-disaster housing reconstruction and livelihood security*

<http://practicalaction.org/t4sl/disasterapproaches>

*Emergency Response and the Natural Environment*

<http://www.natureandpoverty.net/emergency-response>

### Issue 3: Promoting environmentally sustainable livelihoods

Livelihoods depend, both directly and indirectly on natural resources. However resilient an ecosystem may be, it will begin to degrade when human demands on its services outweigh its capacity to recover and replenish them. Once an ecosystem begins to degrade, its productive services continually diminish unless efforts are made to conserve and rehabilitate it.

As the productive services diminish, humans often place greater pressure on an ecosystem to produce (e.g. increasing the use of chemical fertilizers that strip soil of their nutrients, expanding fishing ranges, draining greater expanses of wetlands for agricultural use). Box 6 provides examples of the impacts of ecosystem damage in sub Saharan Africa. Unless the pressure on such ecosystems is relieved, it soon becomes incapable of providing for human needs entirely (e.g. desertification).

#### Box 6: Extended ecosystem damage in sub Saharan Africa

Within the vast stretches of the Sahara Desert, the long-term damage from overgrazing threatens to make life even more difficult for the 60 per cent of Niger's population that survive on less than a dollar a day.

In Botswana, where most of the population depends on agriculture for their livelihoods, soil erosion and unsustainable use of renewable natural resources are putting 40 per cent of the country at risk.

On the island nation of Mauritius, where little arable land is left, the total area suitable for productive agriculture is declining while pressures on the country's remaining forests are increasing.

Source: UNDP – Reclaiming the Lands, Sustaining Livelihoods, accessed at [http://www.undp.org/gef/documents/publications/landdeg\\_brochure2004.pdf](http://www.undp.org/gef/documents/publications/landdeg_brochure2004.pdf)

The development of sustainable livelihoods necessitates balancing the human need for natural resources and the capacity of the environment to provide those resources consistently over time. This illustrates the need for innovative approaches to livelihood and economic development that thoughtfully weigh the lifestyle choices of a population and make changes that favor long term sustainability of natural resources over fast short term economic gains.

#### ***Sub Issue 1: Environmental impacts of livelihood recovery efforts***

When environmental considerations are not integrated in livelihood programming, the interdependence of ecosystems and livelihoods is frequently overlooked. In an effort to quickly restore people's capacity to earn a living, the long term and complex requirements of raising awareness and changing how people interact with their environment are often forfeited for a rapid return to previous unsustainable livelihoods. Without a more comprehensive understanding of the environmental context in which

people strive to support themselves and their households, recovery initiatives often further weaken the ecosystems upon which livelihoods depend.

**Case 9: Environmental and economic impacts of fishing boat replacement in Sri Lanka**

A major challenge after the Indian ocean tsunami of 2004 was an increase in fishing capacity and an ensuing state of over-fishing in a region already over-exploited for fisheries resources. Throughout the region, more small fishing boats were replaced than were lost, expanding fishing fleets to a size greater than they were before the disaster. It is estimated that 19,000 boats were destroyed in Sri Lanka by the tsunami of 2004.

Two and a half years later, some fishermen had not yet fully restored their livelihoods despite assurances from the Reconstruction and Development Agency (RADA) that 90% of the boats have been replaced and that catch levels were then 70% of what they were before the tsunami. Only 30% of large weight boats had been replaced at that time, although these big boats accounted for a third of the overall catch in Sri Lanka before the tsunami. In contrast, there was an excess of small boats that were distributed *ad hoc* by well-wishers, small NGOs and other small donors.

It is estimated that over 3,000 small boats were donated, causing over-exploitation of coastal fish. In southern Sri Lanka, some fishermen now complain that they do not catch any fish at all on certain days. In addition, the ready availability of small boats has resulted in new people turning to fisheries as a livelihood in an already overcrowded coastal fishing industry.

Source: Integrating environmental safeguards into Disaster Management: a field manual Volume 2: The Disaster Management Cycle, Retrieved from [http://www.preventionweb.net/files/9642\\_200805821.pdf](http://www.preventionweb.net/files/9642_200805821.pdf)

**Lesson 1:** This illustrates the critical gap between disaster management and environmental management. By failing to consider the environmental impacts of the initiatives (i.e. the status of fish populations), this wholesale provision of fishing boats, intended to boost the economic recovery of coastal settlements, has created longer term economic instability for the many livelihoods that rely on sustainable fish populations.

**Lesson 2:** The poorly informed provision of fishing boats occurred in many of the 2004 tsunami affected countries. However, in a minority of cases, the replacement of lost boats was done in close collaboration with fishing communities as well as fishermen's cooperatives and associations. In these situations, there were fewer reports of overfishing. This is attributed to the role of the fishermen in determining the number and type of boats to be replaced. Although overfishing had been a pre-tsunami problem, at least in these situations that problem was not exacerbated.

***Sub Issue 2: Learning from indigenous practices***

Many societies have built up, through hundreds of years of experience and intimate contact with the environment, a vast body of knowledge on environmental conservation and disaster management. This knowledge, passed through generations and tested by time, is a valuable resource that can ensure more sustainable livelihood practices while mitigating the adverse impacts of natural disasters in these areas. In the design of environmental and livelihood programming, building upon indigenous skills and knowledge increases the social acceptability of new approaches, facilitates awareness-raising and is often more easily replicated in similar socio-economic and environmental contexts.

**Case 10: Indigenous flood mitigation in Assam**

Nandeswar Village is located in the Goalpara District of Assam, India. Most of the people of Nandeswar Village are farmers. Their livelihoods depend on the land and agro-based activities. Assam and other northeastern states frequently experience floods during the monsoon months from June to September.

The area's physical conditions and factors such as deforestation, land use pressure, rapid population growth and river channel stresses have caused constant shifting of river courses and channels, as well as erosion of river banks within the Brahmaputra river basin. During heavy rains, large areas surrounding Assam are submerged, forcing many villages and towns in Assam to become isolated. In particular, breached embankments and roads, broken bridges and landslides typically leave people stranded.

People have learned to prevent losses by using viable methods that have been practiced for generations. Certain traditional techniques can help rivers and channels from getting silted and prevent excessive run offs during heavy rains. Floods often breach bunds (embankments) and damage roads that are important links between villages. Planting bamboo helps to protect the bunds from being breached and prevent rapid run off from the river channel when the river overflows during heavy rainy days. Moreover, planting bamboo along fish ponds and paddy fields prevents soil erosion and stops water from submerging low areas during peak flooding days.

In preparation of the arrival of monsoon days from December to February, people in Nandeswar Village usually clear the river channels from silt and sand. Removed matter is then used to build bunds along the river and channel. Grass is grown to pad the bund surface and keep the soil from being eroded. Grassroots help bind the top soil. After a month, bamboo shots are planted in pits that are spaced 24 inches over the bunds. The process is done through a local planting method known as bamboo root pressure technique. As bamboo grows, its deep-seated roots exert pressure in all directions of the main shoot allowing newer shoots to grow and the roots to bind the soil. Bamboo roots run on the surface (i.e. near the top soil) to 2.5 to 3 feet and on deeper soil to up to 5 feet.

The local people obtain many benefits from this plantation technique. While soil erosion is checked, the bamboo grown within a period of 5 years is also used as material for construction, crafts making and paper making. These activities provide additional employment to the community. Cost for repairing and maintaining the bunds remains low. De-silted soil from river channels are put to good use in various agriculture activities.

Source: UNISDR, Indigenous Knowledge for Disaster Risk Reduction, Retrieved from [http://www.preventionweb.net/files/3646\\_IndigenousKnowledgeDRR.pdf](http://www.preventionweb.net/files/3646_IndigenousKnowledgeDRR.pdf)

**Lesson 1:** This flood mitigation method requires less investment for repairs and maintenance of embankments while reducing siltation during heavy rains and preventing river channels from overflowing.

**Lesson 2:** The use of existing ecosystem species (in this case, bamboo) diminishes the probability of any adverse impacts on the environment. Introducing new species can be ecologically 'risky', as they may be invasive and upset an ecosystem's balance by out-competing native species for natural resources.

**Lesson 3:** Indigenous practices are most often based on sound principles developed through the interaction between humans and nature over centuries. By beginning with such practices, effective measures can be identified and modified that build upon generations of people's own experience with their environment. This improves the likelihood of social acceptance, replication, and sustainability.

### ***Sub Issue 3: Adapting improved livelihood practices***

Factors such as increased population and greater demand of natural resources have led to overfishing, desertification, deforestation, and other forms of ecosystem degradation. Yet, in many cases it not the use of natural resources, but the means by which these natural resources are acquired and managed that damage ecosystem health. For example bottom trawling, drift nets and explosives are fishing methods that heavily damage the marine ecosystems upon which the fish rely. The extensive use of chemical fertilizers and pesticides are agricultural practices which can strip soils of valuable nutrients, thus diminishing their capacity to support the growth of crops.

With appropriate technical assistance, often simple changes in livelihood practices can limit the toll taken on environmental resources and simultaneously mitigate potential disasters. In the mountainous terrain of Grenada, the government's Extension Division of the Ministry of Agriculture, has worked with farmers to increase the use of contour plowing. This simple type of plowing creates crop row ridges perpendicular to the slope that act as small dams slowing the water flow and increasing its infiltration. This in turn, controls runoff water from stripping the soil of valuable nutrients and triggering potential mudslides (Roberts & Shears, 2008).

In many cases, improved livelihood practices have even permitted communities to reclaim abandoned lands, previously considered ‘wastelands’. New, and sometimes traditional, farming practices have been employed that rehabilitate the land while rendering it productive. In the northern regions of Burkina Faso, farmers with government assistance have been able to stave off desertification by using a modified traditional agricultural practice called pit planting (See Case 11). Not only has this rendered abandoned lands productive, it has increased soil fertility and reduced the damaging impacts of recurring droughts.

### Case 11: Increasing arability of land through planting pits in Burkina Faso

In the 1970s, the densely-populated northern part of the Central Plateau of Burkina Faso faced an acute environmental crisis. Some 80% of land in the central part of the Yatenga region was under permanent cultivation for sorghum and millet, but fallow had practically disappeared as a means to restore soil fertility, and 40% or so of this cultivated land was marginal to agriculture. By 1980, the Yatenga region was considered to be the most degraded part of Burkina Faso. Continual droughts led to frequent crop failure, and the region experienced substantial outmigration to less densely populated regions with better soils and higher rainfall. Women had to walk longer distances to collect firewood. Vegetation was destroyed for firewood, and also to expand farms. Groundwater levels fell by an estimated average of a metre per year, and many wells and boreholes ran dry just after the end of the rainy season. Frequent droughts made cultivation of upper and mid slopes increasingly difficult and, as farmers migrated to the lower slopes and valley bottoms, the area of completely barren land increased dramatically.

In this difficult context both farmers and NGO technicians began to experiment with soil and water conservation (SWC) techniques. The farmers concentrated on improving traditional planting pits called *zai*, and NGO technicians concentrated on building stone bunds along land contours. Traditionally, Rehabilitation of Barren Land planting pits were used on a small scale to rehabilitate rocky, barren land that rainfall could no longer infiltrate. Over the years innovations were added, increasing the dimensions of the pits and adding manure, which concentrated water and nutrients. The combination of both techniques proved to be very effective in the rehabilitation of badly degraded land. Thus, agricultural intensification in the region started in the early 1980s when SWC technologies became available that were simple, easily mastered by all farmers, and quickly increased yields.

Soil fertility has been restored to tens of thousands of hectares of degraded land using the *zai* technique. An increased supply of fodder supported greater livestock numbers, in turn increasing manure supplies for raising soil fertility. Due to water harvesting efforts, groundwater recharge improved significantly: wells that used to run dry in the dry season now provide water year-round. Farmers reported substantial productivity gains, with millet and sorghum yields increasing by 50% on average. These processes were

supported and complemented by external intervention. In 1985-2000, substantial public investment has taken place in soil and water conservation. The socio-economic and environmental situation on the northern part of the Central Plateau is still precarious for many farming families, but the predicted environmental collapse has not occurred and in many villages there are indications both of environmental recovery and of poverty reduction.

Experience has shown that acceptance of the techniques used in Burkina Faso spreads quickly, thanks to their simplicity and effectiveness. The success of zaï planting pits and stone contour bunds has now been documented all over the Sahel region, particularly in Mali and Niger. In one such example, the benefits of this innovation spilled over into Illéla, Niger in a powerful demonstration of the value of farmer-to-farmer sharing of ideas. By seeing what their neighbours had done, the Illéla farmers became convinced that the benefits were worth investing in. They implemented the zaï technique on their degraded land, and the practice saved them from the worst effects of the 1990 drought. By 1998, 9,000 hectares had been rehabilitated, or some 15% of the cultivated area. Farmers even began buying degraded land, confident they could restore it, and land that was previously considered worthless now saw rising market prices. The practice continued to spread after the life of the project.

Source: Green Breakthroughs, Retrieved from [http://www.unep.org/dec/PDF/Green\\_Breakthroughs.pdf](http://www.unep.org/dec/PDF/Green_Breakthroughs.pdf)

**Lesson 1:** The use of a participatory approach in which the farmers played an equal role in identifying the problems and experimenting with different interventions resulted in greater farmer ownership of the process. By beginning with the farmer's expertise and collaboratively building upon it, the resulting methods were owned by the farmers.

**Lesson 2:** The process also ensured that potential solutions remained within the technical, social, and economic constraints of the farmers. This resulted in an approach that was both simple and effective.

**Lesson 3:** In tenuous conditions, demonstrating the impacts is critical if the alternative method is to be accepted. Even simple changes to livelihood practices may be high risk for low income populations whose livelihoods rely on existing strategies. Crop failure even for one season, can have devastating results on family and community welfare. The use of pilot plots for experimentation and demonstration purposes is recommended.

**Lesson 4:** The selection of farmers in the initial phase is very important in promoting involvement of other farmers. Ideal candidates are those

who are well-respected and actively involved in the farming community.

**NOTE:** Land ownership is a key ingredient to successful technology transfers. Few are willing to invest in the longer term sustainability measures when land tenure is uncertain.

***Sub Issue 4: Diversifying livelihoods to reduce pressures on the environment***

When alternative practices are insufficient to curb environmental degradation, diversifying the range of income-earning strategies can enable affected populations to meet their livelihood needs while decreasing the strain placed on ecosystem resources.

Livelihood diversification is already a widely-recognized phenomenon amongst rural populations. “Studies of rural income portfolios generally converge on the once startling figure that, on average, roughly 50 per cent of rural household incomes in low income countries are generated from engagement in non-farm activities and from transfers from urban areas or abroad (remittances and pension payments being the chief categories of such transfers)” (Ellis & Allison, 2004, p.5). However rural low-income populations, “tend to diversify in the form of casual wage work, especially on other farms... leaving them still highly reliant on agriculture” (Ibid).

Diversification may take place within a given livelihood strategy, such as diversifying crops, livestock, or fish populations. Diversification may also be cross-sectoral, in which commerce or a skilled trade might supplement the incomes of farmers or fishermen.

In most cases diversification is a reaction to limited earning potential rather than a planned strategy to rehabilitate an ecosystem’s productive services. However, as a proactive strategy, coupled with ecosystem rehabilitation measures, livelihood diversification has been observed to reverse environmental degradation while also providing populations with a “buffer”, when natural events, such as droughts or floods, adversely impact an ecosystem’s productivity.

**Case 12: Rehabilitating grazing land and diversifying livelihoods in Sudan**

Rangelands cover over 60 per cent of Sudan’s land area, supporting one of the largest populations of livestock in Africa. Though more than half the country’s population depends on livestock for their subsistence, cyclical droughts and continuous cultivation have degraded the rangelands, leading to a downward spiral of decreasing crop and livestock production, greater pressures on the soil and declining livelihoods. These problems are compounded by depletion of the existing vegetation cover due to over-harvesting of timber, fuel wood and other forest products. The Community-based Rangeland Rehabilitation initiative supported by UNDP-GEF and implemented by the Animal Resources, and the Ministry of Agriculture, Nature and Land, had two overall objectives:

1. To create a locally sustainable natural resource management system that would

both prevent overexploitation of marginal lands and rehabilitate rangelands for the purpose of carbon sequestration, preservation of biodiversity and reduction of atmospheric dust; and

2. To reduce the risk of production failure by increasing the number of alternatives for sustainable production strategies, leading to greater stability for the local population.

Developed through the support of local NGOs, the project invested in the talents of communities themselves, focusing especially on the participation of women and the poor. The project involved a package of mutually supportive sustainable livelihood activities designed and undertaken by participating villages, including:

- **Institution Building:** mobilizing 17 community groups for planning and implementation of project activities as well as establishing community land management systems that included individual grazing allotments.
- **Training:** in areas such as community development (e.g. soap production and handicrafts), natural resource management (e.g., range management, fodder production, small gardening and livestock rearing), credit systems, and drought mitigation).
- **Rangeland Rehabilitation:** through activities such as sand dune re-vegetation with native perennial grasses and windbreak development through tree planting.
- **Alternative Livelihood Strategies:** by restocking families with sheep; providing a revolving fund to secure better quality seed for increased production from smaller plots; digging strategically placed boreholes and installing water pumps to irrigate women's home gardens that supplement diets and incomes. In addition, less environmentally taxing technologies have been introduced such as energy efficient fuel stoves, and the use of mud brick versus timber for the construction of houses.

The project has already shown economic gains for households by reducing land degradation and increasing land productivity. For example, over 700 hectares of rangeland was improved and properly managed through the project, far exceeding the original goal of 100. But perhaps the best measure of success comes from the fact that neighbouring communities have adopted many of the project's successes, particularly those related to rangeland rehabilitation, boreholes and revolving funds. Word of these successes travelled north and south, carried along by pastoralists travelling their traditional routes.

Source: UNDP – Reclaiming the Lands, Sustaining Livelihoods, accessed at [http://www.undp.org/gef/documents/publications/landdeg\\_brochure2004.pdf](http://www.undp.org/gef/documents/publications/landdeg_brochure2004.pdf)

**Lesson 1:** The diversification of local production systems, through community development activities, eases the pressures on weakened ecosystems while developing more resilient livelihood strategies.

**Lesson 2:** Community mobilization and training can contribute to improved land management and a more secure environmental and social asset base. This, in turn, increases the community's resilience to climate-related shocks, such as drought.

**Lesson 3:** The long-term improvement in natural resource management and land rehabilitation can only be accomplished by meeting the short-term survival and livelihood needs of villagers.

### ***Sub Issue 5: Developing alternative livelihoods***

In situations where an ecosystem's productive services are seriously threatened, the sole means of reversing the damage may be to develop alternative livelihoods. This requires a comprehensive and longer term commitment, capital investment and market infrastructure. However, when well-implemented, the removal of productive stresses on an ecosystem is one of the most effective means of environmental protection and rehabilitation.

To help develop alternative and sustainable livelihoods, comprehensive support on technical, market, and financial support should be provided to the beneficiary groups. A noteworthy example is an alternative livelihood project in Hunshundak Sandland of China. Working with local farmers, the Chinese Academy of Sciences conducted extensive research on the economic and ecological efficiency of chicken farming as a means of reducing the degradation of grasslands due to cattle grazing. Through an ongoing farming and marketing process, the local farmers, now raising chickens, are expected to earn an income at least four times greater. Additionally, natural grasses have rebounded (Adeel & Safriel, 2007).

Recently a growing number of innovative initiatives have developed new livelihood opportunities that provide sustainable incomes, while restoring the protective services of local ecosystems. An example of this is an attempt to reduce the damaging environmental impacts of deforestation in Aceh, Indonesia by replanting economically valuable trees (See Case 13).

#### **Case 13: Reforestation provides livelihood alternatives in Aceh**

Given the importance of tree crops for both economic and environmental development in Aceh and Nias, in 2006 the World Agroforestry Centre (ICRAF), Indonesian Research Institute of Estate Crops (LRPI), Indonesian Institute of Soil Research (ISRI) and partners initiated a project called Rebuilding Green Infrastructure with Trees People Want (ReGrIn).

The project aim is to promote economically valuable trees in the coastal landscape in tsunami and earthquake damaged areas of West Aceh and North Nias. The project is using productive trees that people want; those which can provide environmental protection and improve livelihoods. These productive trees help to increase the resilience of local communities to natural disasters and expedite livelihood recovery and economic development. The western coast of Aceh was the worst hit among all areas affected by the 26 December 2004 tsunami. Economic activity in the region centres on the coast, and the damage caused to markets and transport infrastructure has also had a major impact on people inland.

Even before the tsunami, 40-60% of the economy of West Aceh and Nias depended on tree crops. Trees planted by coastal zone farmers that have economic value are more likely to survive and provide environmental services than trees planted in externally-led reforestation programs. A focus on the type of trees and the way they will be managed is a key to the success of coastal zone management. The ReGrIn project focuses on 11 villages in West Aceh and North Nias, both in tsunami-affected and unaffected areas. The project includes:

- Comprehensively assessing damage to the natural resources and impacts on the livelihoods of the coastal zone population in West Aceh and Nias.
- Developing action plans to target rehabilitation in affected areas with economically valuable tree crops that have been selected on the basis of site-tree matching, remote sensing and soil data.
- Producing high quality planting material, with training and support provided to farmers.
- In the long-term, establishing local processing facilities for tree products and developing special markets and trade in developed countries for products from natural disaster affected areas.

Local people are involved throughout the project, from damage assessment through to plan development and implementation. They are supported by local capacity building institutions and non-government organizations (NGOs). ICRAF is providing technical assistance to farmers, local government and other institutions to improve land use planning and ensure there is integration between the coastal and upland areas.

The ReGrIn project takes an innovative approach; focusing on building the social capital needed for effective coastal zone management rather than meeting physical targets. There is potential for this approach to be replicated in other affected areas, and NGOs are taking an important role in disseminating project information. Through building social capital, improving market links for tree products, and providing farmers with opportunities to continually build their knowledge and skills, there is greater potential for long-term success of the project. It is hoped that the results and lessons from the ReGrIn project, including the role of tree crops in disaster mitigation and socio-

economic recovery, and the impacts of emergency response efforts on the tree crop sector will be valuable in unfortunate events of natural disasters in future.

Source: ICRAF Southeast Asia Project Profiles, accessed at [http://www.worldagroforestrycentre.org/af2/sites/default/files/project%20profiles\\_ReGrIn.pdf](http://www.worldagroforestrycentre.org/af2/sites/default/files/project%20profiles_ReGrIn.pdf)

**Lesson 1:** The sustainability of the ReGrIn project is enhanced by focusing on trees that people want and which they perceive to positively contribute to their livelihoods.

**Lesson 2:** The project illustrates the comprehensive approach necessary for success including:

- Central role of the intended beneficiaries throughout all aspects of the project
- Appropriate environmental expertise to help identify a range of appropriate tree species based on local ecosystem characteristics
- Provision of agricultural technical support and resources to assist the farmers in growing healthy and productive tree crops
- The investment in market infrastructure and the identification of market demands to enable sustainability
- Capacity-building and awareness-raising to all potential stakeholders, not just the farmers

**Lesson 3:** The development of alternative livelihoods is part of a broader initiative to integrate social, economic, political, and environmental concerns in the management of the coastal environment and its relationship with other ecosystems.

### ***Sub Issue 6: Integrated management of ecosystems***

Learning from the past lessons of natural resource management efforts, there has been a growing recognition of the need to take a broader, longer term, multi-disciplinary approach to environmental management. What characterizes these 'integrated' management approaches is:

1. A management scale beyond the boundaries of a single habitat type, conservation area, political or administrative unit to encompass an entire ecosystem (GEF, 2000);
2. The integration of economic and social factors into ecosystem management goals, as the needs of human beings play a major role in the disturbance of ecosystems (Ibid);

3. Flexible, adaptive, and iterative management planning so that management strategies can be adjusted in response to new information changes within the ecosystem (Ibid);
4. The informed participation and cooperation of all stakeholders to assess the societal goals within a given ecosystem or group of ecosystems, and to take actions towards meeting these objectives (EC, 1999); and
5. A prioritized time scale, identifying short, medium and long-term needs and objectives.

Integrated management approaches have been employed most notably in the management of coastal zones, watersheds, forests, river basins, dry lands, and wetlands, and have increasingly focused on climate change adaptation and disaster risk reduction. An essential component of these approaches is the creation of sustainable livelihood options.

### Case 14: Transnational watershed management in Guatemala and Mexico

In 2005 tropical storm Stan dropped torrential rains on the high-altitude upper watersheds of the Coatlán and Suchiate rivers that straddle the borders of Guatemala and Mexico. This caused flooding and mudslides that led to an estimated 2,000 deaths and damages of up to USD\$40 million. Roads, bridges, water supply systems, crops and local economies were destroyed.

These watersheds have been deforested and are badly degraded in many places. In addition to deforestation, coffee plantations have contributed to soil erosion and increased the risk of flooding and mudslides. The region also supplies water to a large number of residents in Mexican and Guatemalan cities located in the lower areas and are the main sources of irrigation for agricultural and livestock purposes. Due to the watershed degradation, communities and industries further downstream are often affected by water scarcity in the dry season. Furthermore, population density in the region is high and the environmental degradation has limited people's livelihood options.

The 2005 disaster propelled communities to take action and find ways to reduce the risks of flooding. With the support of IUCN's Water and Nature Initiative and other organizations, local communities organized themselves and undertook the Tacana watershed project. The main goal of the project was to reverse environmental degradation of the region, reduce risk of devastating floods and landslides and develop more sustainable livelihood options. The four-year project had four main objectives:

1. Consolidate mechanisms for the coordination and management of water resources with an integrated approach,
2. Gather information for creating sub-basin management plans,
3. Implement a strategy for raising awareness and information-sharing, and

4. Build strategic alliances for the implementation of sub-basin management plans in the short, medium and long term.

The IUCN worked directly with local organizations and initiated alliances between local groups through numerous pilot projects which created knowledge-sharing networks. Local communities were informed of the consequences of unsustainable environmental management and were involved in identifying different demands and priorities on water use and watershed management.

The Tacaná Watershed Project initiated micro-watershed councils in Guatemala and similar watershed committee in Mexico. In Guatemala, the formation of councils helped the affected communities to strengthen water governance in a country where water management regulations were virtually non-existent. Driven by the need to expand their livelihood options to reduce poverty, these community councils have diversified farming systems, including terracing of degraded slopes and reforestation through the introduction of agro-forestry. Additionally, a voluntary association was formed that built 19 greenhouses and received certification from the Exporters Association of Guatemala for growing flowers and plants.

Municipalities in Mexico and Guatemala also collaborated in the project by integrating their micro-basin management policies. An agreement between the two countries, the Tapachula Declaration, was signed to develop joint projects on watershed management.

Source: IUCN Water and Nature Initiative, and IUCN Central America, Retrieved from <http://www.iucn.org/es/sobre/union/secretaria/oficinas/mesoamerica/>

Environment as infrastructure – Resilience to climate change impacts on water through investments in nature, Retrieved from <http://www.waterandclimate.org/index.php?id=5thWorldWaterForumpublications810>

**Lesson 1:** Where ecosystems have incurred severe damage, a multi-sectoral management approach is important to ensure that the links between the various livelihood and environmental aspects are recognized and addressed.

**Lesson 2:** In many cases, acute disasters are the sign of larger environmental issues. Careful assessment can help to identify both the short and long term needs to strengthen the resilience of ecosystems and the communities that rely upon them.

**Lesson 3:** Large-scale sustainable management projects can be made possible, but require attention to careful integration and synchronization of local initiatives.

**Lesson 4:** Without the support of government policies and corresponding regulatory frameworks, sustainability of such large-scale initiatives can prove challenging.

**Lesson 5:** Large-scale sustainable watershed management can reap economic benefits by decreasing local vulnerability to floods and storms, and ensuring the future productivity of local agriculture plots.

For further reading on the promotion of environmentally sustainable livelihoods please see:

*Ecosystems, Livelihoods and Disasters. An integrated approach to disaster risk management*

<http://data.iucn.org/dbtw-wpd/edocs/CEM-004.pdf>

*Coping with disaster: Rehabilitating coastal livelihoods and communities*

<http://www.worldfishcenter.org/v2/files/Pomeroy%20framework.pdf>

*Livelihood diversification and natural resource access*

<http://www.fao.org/docrep/006/ad689e/ad689e00.HTM>

*The new generation of watershed management programmes and projects*

<http://www.fao.org/docrep/009/a0644e/a0644e00.htm>

*Reclaiming the Land Sustaining Livelihoods*

[http://www.undp.org/gef/documents/publications/landeq\\_brochure2004.pdf](http://www.undp.org/gef/documents/publications/landeq_brochure2004.pdf)

*Recovery and sustainable development of aquaculture industry in tsunami affected Aceh and Nias provinces in Indonesia*

<ftp://ftp.fao.org/docrep/fao/009/a0974e/a0974e08.pdf>

*An introduction to the Chars Livelihoods Programme*

<http://www.clp->

[bangladesh.org/index.php?option=com\\_docman&task=cat\\_view&qid=56&Itemid=99](http://www.clp-bangladesh.org/index.php?option=com_docman&task=cat_view&qid=56&Itemid=99)

*The sustainable community rehabilitation handbook*

<http://www.hyogo.uncrd.or.jp/publication/pdf/Guide/HandBook.pdf>

*Disaster Risk, Livelihoods and Natural Barriers, Strengthening Decision-Making Tools for Disaster Risk Reduction – A case study from Northern Pakistan*

<http://www.preventionweb.net/english/professional/publications/v.php?id=4156>

*Adjusting to Floods on the Brahmaputra Plains, Assam, India*

<http://www.preventionweb.net/english/professional/publications/v.php?id=12782>

## Issue 4: Rehabilitating ecosystems

Over long periods of time and within dynamic conditions, ecosystems form elaborate processes to protect and sustain themselves. These elements of an ecosystem, such as the growth of mangrove forests along coasts or the existence of natural wetlands along waterways, are natural processes that prevent or lessen the impacts of extreme natural events such as floods and windstorms. Humans, for thousands of years have recognized and benefitted from these protective services. However the protective capacity of ecosystems has been severely degraded as development demands have increased. We are now beginning to understand the price paid for the unobstructed exploitation of these ecosystem services, and new efforts have been made to evaluate the benefits of protecting and maintaining the protective features of the environment. The examples in Case 15 show how investments in protecting ecosystems can lead to significant savings, as compared to the cost of a disaster on human lives and livelihoods.

### Case 15: The value of safeguarding ecosystem services in economic terms

It is hard to place a value on ecosystem services, as the value is infinite. However there has been a growing trend to give ecosystem services an economic value as a means to ensure their consideration in the development of policies and programs. The process of valuing ecosystem services consists of five basic steps (DEFRA, 2007):

1. Establish the environmental baseline.
2. Identify and provide qualitative assessment of the potential impacts of policy options on ecosystem services.
3. Quantify the impacts of policy options on specific ecosystem services.
4. Assess the effects on human welfare.
5. Value the changes in ecosystem services.

Following are several examples of the economic value of safeguarding ecosystem services:

**New Zealand:** The Whangamarino Ramsar site is the second largest bog and swamp complex in North Island. The wetland has a significant role in flood control (the value of which has been estimated at US\$601,037 per annum at 2003 values) and sediment trapping (Schuyt & Brander, 2004). Values can rise in years when there is flooding and it is estimated that flood prevention in 1998 was worth US\$4 million alone. There have been 11 occasions when the wetlands have been needed to absorb floods since 1995 (Dept. of Conservation, 2007).

**Madagascar:** Mantadia National Park, established in 1989 as an outcome of Madagascar's National Environmental Action Plan, includes the watershed of the Vohitra River. A productivity analysis measured the economic benefits of the park due to reduced flooding, as a consequence of reduced deforestation, to farmers in the region. The results indicated that conversion from primary forest to slash and burn cultivation

can increase storm flow by as much as 4.5 times. The study quantified the benefits from forest protection within upper watersheds in terms of reduced crop damage from floods in agricultural plots in lower basins and concluded that the net value of watershed protection (in 1997) was US\$126,700 (612 times greater than the per capita GNP – US\$207). This represented the benefits gained from alleviation of flood damage thanks to the watershed protection function of the Park (Kramer et al., 1997).

**Malaysia:** The value of maintaining intact mangrove swamps for storm protection and flood control in Malaysia has been estimated at US\$300,000 per km, which is incidentally the cost of replacing them with rock walls (Ramsar, 2005).

Sources: Natural Security: Protected areas and hazard mitigation, Retrieved from [http://assets.panda.org/downloads/natural\\_security\\_final.pdf](http://assets.panda.org/downloads/natural_security_final.pdf)

An Introductory Guide to Valuing Ecosystem Services, Retrieved from <http://www.defra.gov.uk/environment/policy/natural-environ/documents/eco-valuing.pdf>

In addition to protecting ecosystems from future degradation, many efforts to rehabilitate damaged ecosystems have met with quantifiable success. Case 16 describes a mangrove replanting effort in Vietnam and the benefits it has provided in the face of typhoons.

### Case 16: Mangroves protect coastal communities of Vietnam

Vietnam is one of the most typhoon-lashed nations in Asia. Every year, an average of four sea-born typhoons and many more storms wreak havoc on this low-lying country. In what may seem a curious pursuit for a humanitarian organisation, the Vietnam Red Cross (VNRC) has been planting and protecting mangrove forests in northern Vietnam since 1994.

The reason for its commitment to mangrove protection, which has included planting nearly 12,000 hectares of trees and defending them from shrimp farmers who want to hack them down, is a simple one: mangroves protect Vietnam's coastal inhabitants from the ravages of typhoons and storms. These submerged, coastal forests act as buffers against the sea, reducing potentially devastating 1.5 metre waves into harmless, centimetre-high ripples. The mangroves planted by the VNRC protect 110 kilometres of the 3,000-kilometre sea dyke system that runs up and down Vietnam's coastline. With financial support from the Japanese and Danish Red Cross, it is planting four different species, which reach a height of 1.5 metres after three years.

The benefits are staggering. In financial terms alone, the mangrove programme proves that disaster preparedness pays. The planning and protection of 12,000 hectares of mangroves has cost around \$1.1m, but has helped reduce the cost of dyke maintenance by \$7.3m per year. In lives spared, one need only look to the dividend reaped during typhoon Wukong in October 2000. This typhoon pummeled three northern provinces, but caused no damage to the dykes behind regenerated mangroves and no deaths

inland from these dykes. In the past waves would breach the coastal dykes and flood the land of poor coastal families.

As well as the lives, possessions and property saved from floods, the VNRC estimates that the livelihoods of 7,750 families have benefited from the replanting and protection of the mangrove forests. Family members can now earn additional income selling the crabs, shrimps and mollusks which mangrove forests harbour – as well as supplementing their diet.

Over the last 50 years shrimp farming, coastal development and chemical defoliants dropped during the Vietnam war have severely damaged mangrove forests. But their regeneration is crucial. As sea temperatures and levels rise, more severe typhoons and storm surges can be expected. This could be disastrous for the inhabitants of Vietnam's east-facing coastline. This risk has spurred the Red Cross to continue investment in mangrove regeneration, despite continued threats from coastal shrimp farmers and developers. It is just as well. Those who live inland from sea dykes are a little less at the mercy of typhoons and storms now. And they hope to keep it that way.

Source: The Environment Times, Retrieved from <http://www.grida.no/publications/et/ep3/page/2610.aspx>

When stress is removed from ecosystems, they begin to recover naturally. Yet the rate at which their protective services are restored is directly related to the degradation incurred. The rehabilitation of clear cut slopes to stabilize soils and reduce landslide risks can take many years if left to recover naturally. In these types of scenarios, more active forms of ecosystem rehabilitation (such as replanting) can help to accelerate the process. The World Conservation Union provides the following guidance to consider before embarking on ecosystem rehabilitation (IUCN, 2006):

- species are very site specific and not all areas are suitable for replanting;
- carry out restoration with reference to existing national laws;
- ensure that all relevant stakeholders are involved (local communities, government departments) and are given the opportunity to make informed decisions;
- rehabilitation activities should strive to provide direct livelihood benefits in an equitable manner;
- prevent the spread of invasive species if possible; use native species when replanting;
- due to the unpredictability of ecological and social processes, an adaptive management approach is recommended.

### ***Sub Issue 1: Creating protected areas***

The protection of natural areas, for cultural, economic, and even disaster mitigation reasons, has occurred for hundreds of years by populations across the globe. As early as

the 15<sup>th</sup> and 16<sup>th</sup> centuries, Japan has protected vast expanses of forested land in order to reduce the risk of landslides due to deforestation (Stolton et al., 1998). In more recent times, development demands have largely overridden most efforts to preserve ecosystems that prevent or mitigate natural disasters. Yet, the lessons drawn from poor environmental management has motivated many governments in the wake of a disaster to enact new laws protecting those ecosystems that reduce disaster impacts.

According to the World Wildlife Fund, creating protected areas (through such measures as zoning regulations and the establishment of reserves) “maintains natural ecosystems, such as coastal mangroves, coral reefs, floodplains and forest that may help buffer against natural hazards” and “provides an opportunity for the active or passive restoration of such systems where they have been degraded or lost” (Ibid).

Although a highly effective means of rehabilitating ecosystems and their protective services, the creation of protected areas immediately following a natural disaster can pose an array of significant challenges. Two noted challenges are the resettlement of populations living within the area and the loss of livelihoods of those who relied on the area’s natural resources. When the establishment of protected areas has not coincided with alternative livelihood opportunities, displaced populations have commonly returned to their original lands and natural resource exploitation has continued in spite of regulation.

### Case 17: Coastal Buffer Zone in Sri Lanka

Central to the process of reconstruction, following the 2004 tsunami’s impact on Sri Lanka, was the government’s announcement that it would enforce a ‘no-build’ coastal buffer zone of 200 meters in the north and east coasts of the country and 100 metres elsewhere. It was announced that residents within the zone would not be permitted to rebuild damaged or destroyed buildings

In the buffer zone where construction was not to be permitted, the guidance of 15 March 2005 stated that the government “will identify land closest to the affected village and provide houses to the affected families. As far as possible, the relocation process will attempt to keep communities intact”. The following assistance policy was to apply:

- No reconstruction of houses (partially or fully damaged) will be allowed within the buffer zone.
- All affected households will be provided with a house built with donor assistance on land allocated by the state. Households will not be required to demonstrate ownership to land.
- The new homes will be built in line with guidelines issued by the UDA and will have a floor area of 500 sq. ft. and would be provided with electricity, running water, sanitation and drainage facilities.

- The proposed houses in urban and rural settlements will have facilities such as road systems, recreation, etc.

Owners of damaged houses were to be allowed to keep their land for agriculture and would be offered free land and houses at an alternative site. Undamaged houses and hotels (even if damaged) would be allowed to remain in the buffer zone. For residents within the buffer zone, the government planned to assist not only landowners, but all residents (including encroachers) with some form of housing. This was estimated to require around 50,000 permanent houses.

The government enacted the buffer zone quickly as a means to prevent people from moving back to the affected coasts and felt a uniform approach was the fairest and quickest way to do so. However, the uniform 100 and 200 meter limits appeared arbitrary:

1. The zone limits were not based on prior community consultations and did not correspond to tsunami damage.
2. They did not take into account topographical and other relevant features of the land that would affect hazard risks.
3. There was also dissatisfaction that the rules applied only to residents whose houses were damaged but not to tourist enterprises who would be permitted to rebuild, and that households whose houses had not suffered damage were permitted to continue living in them.

The buffer zone became a politically controversial issue, generating significant opposition from community and business groups.

While many tsunami victims, particularly those whose houses had been severely damaged by the tsunami and had lost family members, were not enthusiastic about rebuilding in the same location, they were concerned about being relocated away from their places of employment or business and about the possibility that they would lose their properties to others (such as tourist enterprises who could rebuild). Many tsunami victims were fishermen who need to keep their boats and supplies near the shore while some fishing activities – such as drawing in of large nets – require community participation. In urban and densely populated areas, relocation of business-related buildings to an interior location could be very costly.

Source: Post-Tsunami Recovery: Issues and Challenges for Sri Lanka, Retrieved from <http://www.adbi.org/files/2005.10.dp39.tsunami.recovery.srilanka.pdf>

**Lesson 1:** Although the concept of a buffer zone for coastal eco-system management does have considerable value – without applying the regulation uniformly to all, significant frustration, a lack of trust in the government, and, in some cases, a disregard of the rules altogether can ensue.

**Lesson 2:** One possible approach to identifying a more relevant buffer zone would be to enforce a building moratorium until more detailed risk assessments could be made of the coastlines under consideration.

**Lesson 3:** In many cases, public frustration with governmental policies can be mitigated by engaging the affected communities in the policy-making process. Local communities can provide valuable data on potential local issues and negotiate towards a more mutually beneficial solution. Transparent communication that informs the public of policy issues, solutions and justifications on an on-going basis helps to maintain public trust and provide communities with the information needed to initiate their own recovery efforts.

**NOTE:** The majority of disaster reconstruction guidance advises against the development of buffer zones when it results in significant relocation. One common alternative is to allow reconstruction of pre-existing residences if the new buildings can meet acceptable disaster resistant standards.

Innovative solutions have been found to establish protected areas while still meeting the livelihood needs of local populations. One approach has been to link the livelihoods of local communities with revenue sources generated through the sustainable use of the area's resources. "The basic idea is that if living resources are redefined as an asset of local people (whether completely, or shared with other stakeholders), and revenue streams from their use distributed fairly according to the ownership, then the whole incentive structure will automatically change, and values and behavior with it" (UNEP, 2008). This approach has proved successful in conserving forests and wildlife in Zimbabwe (Kesare, 2009), protecting fish sanctuaries in the Philippines, and preserving reefs in Indonesia. A present program in the Philippines addresses the risks of floods and mudslides due to deforestation, by turning over land to local people to reforest with economically valuable fruit trees (See Case 18).

**Case 18: Reforestation to protect ecosystems and reduce disaster risk in the Philippines**

Through a partnership between the Toyota Motor Company, Conservation International, the Philippine Department of Environment and Natural Resources, and Local Government Unit of Peñablanca, 2,500-hectares of formally barren mountainside is now dotted with more than 18,000 mango trees and 680,000 other indigenous forest trees. 22,000 more mango trees are scheduled to be planted and the project aims to expand the growth of rambutan, pomelo, langka (jack fruit), cacao and other trees endemic to the area.

The project has three objectives: Reducing risk of landslides and flooding; providing sustainable economic opportunities for local communities; and rehabilitating the forest ecosystem.

**Disaster risk reduction:** Peñablanca is located on the northeast side of Luzon Island. The

island, along with the rest of the country is heavily prone to typhoons, earthquakes, and floods. Due to extensive deforestation, many communities in north Luzon are additionally at risk of mudslides. The large scale reforestation project aims to stabilize the soil, thus reducing the mudslide risk, and decrease surface water runoff to reduce the frequency and intensity of floods, both locally and downstream.

**Local economic development:** Local communities have taken responsibility for the growth of the fruit trees. Once the trees have matured, the fruit can serve as income source. To help the project become sustainable even after the six-year project term, 10 percent of the income from the mango harvest will go back into a reforestation fund. Additionally, the area is home to the headwaters of the Cagayan River. The river serves the country's largest rice-growing region. It is hoped that the reforestation project will reduce siltation and regulate flooding downstream.

**Ecosystem rehabilitation:** The site is recognized as having globally significant levels of biodiversity and thus a priority for conservation action. It is home to a diversity of unique species, found only in the Philippines. A number of these same species are also threatened including vertebrates like the country's national bird, the Philippine eagle, the Crown Flying fox and the Gray's Monitor Lizard. The project aims to protect the biodiversity of the region.

To discourage people from cutting trees for firewood, project members have educated and encouraged communities to plant fast-growing ipil ipil trees in designated areas for firewood. Toyota and Conservation International will also provide rice-hull stoves for 900 families in the area. Livestock has also been restricted from grazing in the area to give vegetation ample time to regenerate.

An external evaluation was conducted by the Rainforest Alliance and the project was certified as meeting the international "Climate Community and Biodiversity Standards" certified by the Climate, Community & Biodiversity Alliance.

Although too early to tell, there have been reports from local forest rangers and conservationists that the area experienced less soil runoff and reduced flooding when hit for several days by Typhoon Pepang in October, 2009.

Sources: Conservation International, accessed at [http://www.conservation.org/sites/celb/news/Pages/01292010\\_Toyota\\_Philippines\\_Project.aspx](http://www.conservation.org/sites/celb/news/Pages/01292010_Toyota_Philippines_Project.aspx)  
Philippine Daily Inquirer, accessed at [http://services.inquirer.net/print/print.php?article\\_id=20091102-233517](http://services.inquirer.net/print/print.php?article_id=20091102-233517)

**Lesson 1:** Bringing together the many stakeholders needed to restore an ecosystem requires negotiating varied objectives and developing innovative solutions that satisfy the needs of all concerned.

**Lesson 2:** The health of ecosystems can influence other ecosystems. In this case, deforested slopes not only damaged the protective and productive services of the mountainside environment, but endangered rice production in lowland

areas due to siltation and flooding. This indicates the need for comprehensive environmental assessments to map out the complex set of relationships and avoid unexpected adverse impacts.

Cases have been documented where local populations have recognized the impacts of environmental degradation and have organized to mitigate damage and loss by rehabilitating local ecosystems. One such example (See Case 19) comes from the Madhumalla community of Nepal, who mitigated the impacts of frequent flooding and landslides due to the combined effects of environmental degradation and the monsoon rains.

**Case 19: Locally driven flood plain management in Nepal**

The Madhumalla community in southeastern Nepal offers a compelling example of how a grassroots bioengineering initiative not only helped to reduce the threat of flooding in the local area, but also provided additional ecosystem goods and services.

The Himalaya range, home to some 1.3 billion people, is among the richest freshwater bodies on Earth. The area's rugged yet dynamic mountain system is highly prone to mass wasting (e.g. landslides and avalanches) while seasonal monsoon precipitation often brings extreme natural events which threaten the ever-increasing population in an already densely populated region. Located along the central belt of the Himalaya range, Nepal has been subject to the risks associated with mass-wasting and flooding each year. The floods not only threaten the lives and livelihoods of its population, but they also account for more than half of disaster-related deaths in the country.

The community of Madhumalla in the Morang district in southeastern Nepal is located on the right bank of Mawa River—a small rain-fed river with an upper watershed of just about 20 km<sup>2</sup>. This 25 km long river has an average gradient of 4% in the upper reaches and 2% in the lower reaches, and a width varying between 200 and 700 m. Like most rivers originating in the southern belt of Nepal, Mawa River faces unpredictable flooding mainly caused by monsoon rain. Sudden cloud-bursts in the upper watershed often generate torrents laden with debris, boulders and sediments. The process brings about rapid changes in river morphology with a cycle of aggradation and degradation of river bed, undercutting, erosion and overflowing of river banks, and shifting of the entire river course. Consequently, the population living in the vicinity is under a constant threat of severe flood damage to their homes, crops and community.

In the mid-1990s, the Madhumalla community, then led by Chairman Kashi Nath Paudyal, embarked on a mission to address the threats posed by the unpredictable and devastating floods that had occurred in the area. The community began planting a series of stratified green belts along the river consisting of some 6,500 varieties of native trees, shrubs and grasses. Reinforcing materials were installed to prevent the undercutting and erosion of the banks and the degradation of the flood plains. Structural additions such as embankments and spurs made of gabion boxes were placed at selected locations as an

additional protection measure for the green belt. The project was designed and implemented on the basis of the community's indigenous knowledge. This included experiences regarding the characteristics of locally available plant varieties vis-à-vis their relative strengths to withstand forces of river water, as well as an understanding of the local physical environment and the river morphology. Much of the funding was also mobilized locally in the form of cash, labour, and material assistance. National and international donors also contributed US\$ 40,000 in grants.

The project was a huge success and has been replicated in several other communities in the region. Not only have the plantings been able to effectively mitigate the threat of flooding, but the plantings are also producing income from the sale of forest products. It is expected that in a few years, the project will generate hundreds of thousands of US dollars annually for the local community. Currently, the project area is serving as a training centre for bioengineering technology.

Source: Water, Wetlands and Forests. A Review of Ecological, Economic and Policy Linkages, Retrieved from <http://www.cbd.int/doc/publications/cbd-ts-47-en.pdf>

**Lesson 1:** Locally-driven initiatives can provide excellent opportunities for government support. These initiatives often share the support of local public; align with local environmental, social, and economic conditions; replicate easily in surrounding areas; and prove more sustainable.

**Lesson 2:** Strong leadership is a major factor in the success of ecosystem rehabilitation. Negotiating divergent, and sometimes conflicting, objectives while motivating people to work towards long-term benefits are significant challenges. Surmounting these challenges requires leaders that are in tune to local realities and well respected and trusted by local communities.

### ***Sub Issue 2: Protecting ecosystems through eco-tourism***

In 2004, ecotourism/nature tourism was growing globally 3 times faster than the tourism industry as a whole (WTO 2004, cited in TIES 2006). This increasing trend in the tourism industry depends on the conservation of the natural environment and can serve to rebuild and strengthen economies while protecting and rehabilitating protective environmental resources. The most widely used definition of ecotourism is the “travel to fragile, pristine, and usually protected areas that strive to be low impact and (usually) small scale. It helps educate the traveler; provides funds for conservation; directly benefits the economic development and political empowerment of local communities; and fosters respect for different cultures and for human rights” (Honey, 1999, p. 25).

Heightened environmental awareness in many countries has led to an increased demand for environmentally sustainable tourist destinations and a greater willingness to invest in such ventures.

To reverse deforestation in the 1980s and 1990s, Costa Rica took on major initiatives to make sustainable, nature-oriented tourism the primary theme of its growing tourist industry. The government expanded protected areas to one quarter of the country's land area, taxed unsustainable activities, and provided tax relief for the protection privately owned rainforest, and developed strict laws to prevent environmentally damaging development (UNEP, 2008). By 2007, Costa Rica's approach had created a US\$ 1.92 billion dollar tourism industry for the country (Fassel, 2006), and its environmental performance was rated as the fifth in the world by the Environmental Performance Index (Yale University, 2008).

As a post-disaster response, a growing number of actors - government, private sector, and civil society - have invested in ecotourism initiatives as a means to revitalize local economies while preserving the protective services of local ecosystems. Following the Typhoon Morakot that hit Taiwan in 2009, the Maolin Township, representing the aboriginal Rukai people, has abandoned plans of large-scale development to focus on ecotourism as the local economic driver (Liberty Times, 2009). Communities on the island of Lanta, Thailand realized the importance of their natural ecosystems following the tsunami and are working to rehabilitate their natural resources to attract eco-tourists (See Case 20).

### Case 20: Developing eco-tourism in post-tsunami Thailand

The waves had a very serious impact on Thailand's natural environment, with coastal national parks severely damaged, coral reefs destroyed by backwash debris and agricultural land affected by salt-water intrusion. UNDP Thailand immediately initiated a coral reef cleanup programme run completely by a volunteer network. To date, 17 reef areas important to fishing and tourism have been cleared of debris and rehabilitated. Underwater reef trails, signboards, floating fences and mooring buoys have been established in protected areas. On Lanta Island, ecotourism initiatives are underway with nature trails being cut through the jungle, an ecology centre is planned, and a campaign is in the works to promote sustainable tourism and fishing practices in student summer camps.

Developing Lanta Island into an environmentally and economically sustainable tourism destination is part of the strategic development plan of district leaders. Part of southern Thailand, an internationally acclaimed tourist destination, the initiative strives to cultivate the cultural heritage and natural beauty of Lanta Island while providing economic growth through sustainable tourism. "Although the tsunami wreaked much devastation upon our island, it was also a kind of a springboard for the people of Lanta to see that we have to be unified in order to solve our problems and plan for the future,...This development plan that we have devised based on nature and cultural heritage will eventually be designed for the entire island, and will hopefully one day be used at the district level."

Sources: Indigenous Livelihood Restoration and Sustainable Ecology for Lanta Island, Retrieved from <http://www.undp.or.th/resources/download/Lanta.pdf>

Survivors of the tsunami: One year later, Retrieved from [http://www.cs.pitt.edu/s-citi/tsunami/workshop1/UNDP%20\\_%20Survivors%20of%20the%20Tsunami.pdf](http://www.cs.pitt.edu/s-citi/tsunami/workshop1/UNDP%20_%20Survivors%20of%20the%20Tsunami.pdf)

**Lesson 1:** Developing productive and sustainable tourism requires balancing the economic benefits with the often heavy environmental impacts caused by tourism development. This requires planning processes based on environmental impacts, not just financial criteria, and a willingness to forego more immediate economic gains for longer term economic and environmental sustainability.

**Lesson 2:** Tourism is a multi-sectoral industry with many stakeholders. Ensuring sustainability requires a negotiated and shared vision for the overall welfare of the area.

**Lesson 3:** Tourism can have powerful social impacts as well such as the loss of social and cultural identity and values. Sustainable tourism planning should actively consider the importance of such issues and means to address them.

For further information on environmentally sustainable tourism please see:

*Sustainable Coastal Tourism: An integrated planning and management approach*

<http://www.unep.fr/shared/publications/pdf/DTIx1091xPA-SustainableCoastalTourism-Planning.pdf>

### **Sub Issue 3: Awareness-raising**

Public outreach, awareness-raising and knowledge exchange are critical components to the success of any effort to protect and rehabilitate environmental resources. The perception of disasters as uncontrollable acts of nature is widespread and the complex relationship between natural resource management, natural disasters and the protective and productive services of ecosystems is not always clearly understood. Engaging local communities is critical to any risk-reducing effort as it increases the chance of achieving lasting results. However, unless people understand the purpose of their efforts and the necessary means of carrying them out, achieving sustainability will prove difficult.

A UNEP supported study by Wetlands International in Indonesia found that half of 30 million mangrove seedlings planted after the tsunami had died due to a lack of awareness-raising and training on mangrove planting (UNEP, 2008).

In three states in India, 33 villages have worked with forestry officials since 1993 to restore 1,500 hectares of mangroves. So far, three-quarters of the seedlings have

survived, double the rate achieved by other projects. The communities saw the benefits of their work when the trees buffered the impact of the tsunami (Check 2005).

In Sri Lanka, a local initiative to restore sand dunes took advantage of their work to incorporate a training program and public awareness-raising activities for the broader community, as well as targeted individuals. By creating a broader understanding of the important protective features of sand dunes, the initiative hopes to garner support in protecting them from illegal mining.

### Case 21: Rehabilitating sand dunes in Sri Lanka

The Tsunami waves played havoc in the Negombo estuary located in the south-west coast of Sri Lanka. The waves which entered the estuary mouth from the south-west brought in significant amounts of debris causing mechanical damage to mangroves and sea grass beds and making an adverse impact on the hydrology and canal system of the estuary. However, the impact on human life and infrastructure was minimized by the sand dunes running parallel to the sea and estuary. According to the geomorphology of the area, the lands situated between the sand dunes and the estuary are below sea level and nearly 20,000 houses are located between sand dunes and the estuary area. There is a huge demand for sand to reconstruct the houses damaged by the Tsunami. To meet this demand many people are engaged in the illegal mining of the precious sand dunes. Continuation of this indiscriminate activity would result in a major catastrophe in the event of a future disaster like a tsunami or cyclone. If the weakened dune is breached the entire area will be inundated with sea water with frightening consequences.

In order to minimize these threats the project titled: Rehabilitation of the Sand Dune and the Negombo Estuary after the Tsunami damage was implemented by the Negombo Lagoon Management Authority (NLMA). The main goal of this project was to enhance the quality of life of the people who are living in the area by improving coastal ecosystems. The objectives to be achieved were:

1. Improving coastal ecosystems to provide livelihoods to people who depend on such ecosystems
2. Providing a safe environment for people living along the sand dune area
3. Enhancing sustainable resource management capacity of the resource users

The first objective was achieved through several cleaning programs to remove solid waste accumulated in the Negombo estuary, and stocking the lagoon with 300,000 fish. This resulted in increased incomes for lagoon fishermen. Debris from mangrove areas was also removed to facilitate natural re-generation.

The second objective was achieved through the rehabilitation of the sand dune under the technical guidance of the Coast Conservation Department. An eight kilometre length of sand dune was surveyed and GIS maps were prepared. Based on the maps, the dune areas less than 3 meters above MSL (mean sea level) were selected for restoration. Eight

points of the dune covering a total length of 750 m were restored” explained Mr Ranjith Fernando, an experienced fisherman who chairs the NLMA. He went on to say that sand dredged from the Negombo lagoon (under another project) was to be used for this restoration. However, when this project did not take off as expected, sand had to be purchased from other sources putting a strain on the budget and limiting the area to be restored. To facilitate further strengthening of the dune, native plants were planted along each dune.

In order to achieve the third objective eight awareness programs on coastal habitat protection and sustainable use of coastal resources were conducted for fishing communities, teachers, students, police, navy and officers of the Disaster Management Centre in the area. Six sign boards depicting conservation messages on coastal resources management were also erected. “We have formed a ‘vigilance group’ to maintain the sand dune and also to ensure protection of the sand dune from illegal sand mining” concluded Ranjith.

Source: Environmental Stories: After Tsunami, Retrieved from <http://cmsdata.iucn.org/downloads/environment20stories2020final.pdf>

**Lesson 1:** The Negombo project encompasses rehabilitation activities that address both the productive and protective services of the local ecosystems. These activities, when linked to training and awareness raising, can serve as important learning aids to demonstrate the role ecosystems play in supporting livelihoods and reducing disaster risk.

**Lesson 2:** Immediately following a natural disaster, a window of opportunity opens in which people are typically more open to changes in perception and behavior. Engaging affected communities in collective learning during this time can be particularly effective, reaping longer term benefits. However experience suggests that this window closes quickly as the impacts of the disaster fade into the past and are replaced by more immediate needs.

**Lesson 3:** Targeting the local police, navy and disaster managers for training activities is a good approach as they possess the capacity or responsibility to monitor and take appropriate action.

**Lesson 4:** Providing learning opportunities to teachers and students often has impacts that reach beyond the school grounds. Schools are often the learning hubs for entire communities. Children and youth –the quickest learners – frequently serve as valuable sources for family and community knowledge. Additionally training children and youth can promote a generational shift in perceptions of risk and environmental management.

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For further reading on the protection and rehabilitation/restoration of ecosystems please see:

*The Last Straw. Integrating Natural Disaster Mitigation with Environmental Management*

[www.proventionconsortium.org/themes/default/pdfs/last\\_straw.pdf](http://www.proventionconsortium.org/themes/default/pdfs/last_straw.pdf)

*Reducing Risk through Environment in Recovery Operations - An Initial Review of the Status*

[http://www.unisdr.org/preventionweb/files/8293\\_reducing20risk20through20environment20in20recovery1.pdf](http://www.unisdr.org/preventionweb/files/8293_reducing20risk20through20environment20in20recovery1.pdf)

*In the front line: shoreline protection and other ecosystem services from mangroves and coral reefs*

[http://www.unep.org/pdf/infrontline\\_06.pdf](http://www.unep.org/pdf/infrontline_06.pdf)

*Land Use, Disaster Risk & Rewards - A Community Leader's Guide*

<http://www.preventionweb.net/english/professional/trainings-events/edu-materials/v.php?id=4077>

*Managing Mangroves for Resilience to Climate Change*

<http://data.iucn.org/dbtw-wpd/edocs/2006-041.pdf>

*Natural Security: Protected areas and hazard mitigation*

[http://assets.panda.org/downloads/natural\\_security\\_final.pdf](http://assets.panda.org/downloads/natural_security_final.pdf)

*Natural Solutions: Protected areas helping people cope with climate change*

[http://assets.panda.org/downloads/natural\\_solutions\\_climate\\_climate\\_2009.pdf](http://assets.panda.org/downloads/natural_solutions_climate_climate_2009.pdf)

*The Protective Role of Natural and Engineered Defence Systems in Coastal Hazards*

[http://www.preventionweb.net/files/13224\\_HICostalHazardLiteratureReview2007.pdf](http://www.preventionweb.net/files/13224_HICostalHazardLiteratureReview2007.pdf)

*Water, Wetlands and Forests. A Review of Ecological, Economic and Policy Linkages*

<http://www.cbd.int/doc/publications/cbd-ts-47-en.pdf>

## Annex 1

## List of General and Environment-Specific Assessment Tools

1. **Hazard Identification Tool (HIT):** The objective of the HIT is to alert the UN Country Team after the natural disaster to potential secondary risks posed by large infrastructure and industrial facilities containing hazardous materials located in the affected area. This information can be shared with local and national authorities. Any actual secondary risk should be addressed at the earliest possible stage. For more detailed information on HIT and examples from recent disasters, please see:

<http://ochaonline.un.org/OCHAHome/AboutUs/Coordination/EnvironmentalEmergencies/ToolandGuidelines/HazardIdentificationTools/tabid/6458/language/en-US/Default.aspx>.

2. **Flash Environmental Assessment Tool (FEAT):** The FEAT provides a rapid scan to identify the most acute environmental issues immediately following the occurrence of a natural disaster. FEAT focuses primarily on the acute issues arising from released chemicals. It also provides general indications of the type of impacts to be expected from physical occurrences, such as erosion of fertile soil and salt water intrusion. The FEAT user guide can be accessed at:

<http://ochaonline.un.org/ToolsServices/EmergencyRelief/EnvironmentalEmergenciesandtheJEU/ToolsandGuidelines/tabid/5094/language/en-US/Default.aspx>.

3. **Strategic Assessment (SA):** The SA provides the means for undertaking an integrated response and allows senior decision makers to determine the appropriate form of United Nations engagement. It does not aim to repeat previous assessments or validate ongoing programmes, but to indicate possibilities for the United Nations to maximize coherence, focus and impact.

4. **Post-Disaster Needs Assessments (PDNAs):** PDNAs are joint UN-EC-World Bank missions conducted to produce a common post-disaster assessment report by using sectoral PDNA methodologies developed by specialized agencies (such as UNEP, for the environment). They aim to identify priority areas and financial requirements needed for post-disaster recovery and reconstruction. Guides for preparing a PDNA can be found online at:

<http://www.proventionconsortium.org/?pageid=37&publicationid=2#2>

and more recent updated versions at:

[http://haitiregeneration.org/index.php?option=com\\_content&view=article&id=55&Itemid=74&lang=en](http://haitiregeneration.org/index.php?option=com_content&view=article&id=55&Itemid=74&lang=en)

5. **Post-Conflict Environmental Assessment (PCEA)** UNEP uses PCEAs to provide an objective scientific assessment of the environmental situation in a country after a conflict. They aim to inform the general public on environmental risks associated with the conflict, and to provide guidance to governments on priority issues to be addressed. For further information on the PCEA including sample reports, please see

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<http://www.unep.org/conflictsanddisasters/Introduction/PostCrisisEnvironmentalAssessments/tabid/251/language/en-US/Default.aspx>.

6. **Joint Damages Losses and Needs Assessments (JDLNAs):** This joint assessment, generally led by the World Bank Global Facility for Disaster Risk Reduction (GFDRR), specifically aims to identify recovery needs and quantify them. An example of a JDLNA from Madagascar can be accessed at:

[http://gfdrr.org/docs/Madagascar\\_JDLNA\\_Report\\_Final.pdf](http://gfdrr.org/docs/Madagascar_JDLNA_Report_Final.pdf).

7. **Strategic Environmental Assessment (SEA):** The purpose of an SEA is to ensure that environmental consequences of plans and programmes are identified and assessed during their preparation and before their adoption. Public and environmental authorities give their opinion and all results are integrated and taken into account in the course of the planning procedure. After the adoption of the plan or programme the public is informed about the decision and the way in which it was made. In the case of likely significant trans-boundary effects, the affected Member State and its public are informed and have the possibility to make comments, which are also integrated into the national decision making process. Further information on the SEA can be retrieved from:

<http://www.iaia.org/publicdocuments/EIA/SEA/SEAManual.pdf>

and the toolkit can be accessed at:

<http://web.worldbank.org/WBSITE/EXTERNAL/TOPICS/ENVIRONMENT/0,,contentMDK:20885941~menuPK:2450778~pagePK:148956~piPK:216618~theSitePK:244381,00.html>.

8. **Environmental Impact Assessment (EIA):** EIA procedures ensure that environmental consequences of projects are identified and assessed before authorisation is given. The public can give its opinion and all results are taken into account in the authorization procedure of the project. The public is informed of the decision afterwards. A collection of useful resources concerning the EIA can be found at:

<http://www.qdrc.org/uem/eia/impactassess.html>.

9. **State of Environment reporting (SoE):** The State of the Environment (SoE) refers to the prevailing conditions of the region from two perspectives: bio-physical and socio-economic conditions and trends. Ideally an SoE report will seek to address: emerging issues in the region; present environmental status and trends; existing policy responses at national, subregional, and regional level; future perspectives based on the past and present trends of different development patterns; and recommended policy action. SoE reporting will target grass-roots to high-level decision makers. Sample SoE reports can be accessed at:

<http://www.rrcap.unep.org/pub/soe/index.cfm>.

Source: Reducing Risk through Environment in Recovery Operations, Retrieved from <http://www.recoveryplatform.org/assets/publication/reducing%20risk%20through%20environment%20in%20recovery.pdf>

## Annex 2

### Sample Environmental Needs Assessment (ENA) Checklist

Following is a series of checklists based on a question and response format. Not all of the questions below will be relevant to every situation: they need to be modified and possibly expanded to address the different conditions and needs related to specific disasters and local situations. They will also change in relation to the time at which the ENA is being carried out after a disaster. The checklist is adopted from:

*Environmental Needs Assessment in Post-Disaster Situations: A Practical Guide for Implementation. United Nations Environment Programme*

[http://www.humanitarianreform.org/humanitarianreform/Portals/1/cluster%20approach%20page/clusters%20pages/Environment/UNEP\\_PDNA\\_draft.pdf](http://www.humanitarianreform.org/humanitarianreform/Portals/1/cluster%20approach%20page/clusters%20pages/Environment/UNEP_PDNA_draft.pdf)

#### 1. Shelter & Housing

1.1.	Is further evacuation or relocation expected? If so, have proposed relocation sites been screened for environmental criteria?
1.2.	What is the topographical suitability of the site(s) chosen for temporary dwellings?
1.3.	What is the environmental suitability of the site?
1.4.	Are any immediate risks evident, e.g. prone to flash flooding or drought?
1.5.	Have camp planning standards been applied in the design and construction of the settlement?
1.6.	What percentage of households (including vulnerable members of the community) affected by the disaster have adequate shelter?
1.7.	What materials are being used for shelter (cover and supporting materials)?
1.8.	Where are these materials sourced – i.e. are they being provided or do people have to source them?
1.9.	Are the materials used the same as those traditionally favoured by local communities?
1.10.	Are these materials scarce or is there already competition over accessing them?
1.11.	How are construction materials typically obtained and by whom?
1.12.	If wooden poles are being used for supports, are these obtained from

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designated sites and under controlled management?
1.13. Are there obvious environmental impacts from use for any of these materials?
1.14. Are former construction materials being used as temporary shelter?
1.15. What alternatives, if any, exist for alternative shelter materials?
1.16. What environmental impacts might these have (e.g. clay brick making)?
1.17. What are possible environmental implications for reconstruction during early recovery?
1.18. Other?

## 2. Water

2.1. Has the supply of drinking water been affected by the disaster? If so, what is the current situation regarding access to water?
2.2. From where do people displaced by the disaster get water? Tap stand? Water tanker/carrier? Spring/stream? Well? Other? (please specify)
2.3. How much water is provided per person per day? (Note: Sphere standard is at least 15 litres per person per day)
2.4. Have periods of water shortage or unavailability been previously recorded in the affected area? Are these seasonal or related to supply/logistics problems that may affect future supplies?
2.5. Has an assessment of water needs and availability been carried out? If so, does this identify any problems such as exploitation?
2.6. Has the water quality ever been tested? If so, what were the results? (International standard is that there should be no fecal coliforms per 100ml of water at the delivery point.)
2.7. Is water quality being routinely monitored? If so, by whom?
2.8. Is there any evidence or risk of water pollution? If so, what is the point source(s) and extent of pollution?
2.9. What are the actual or possible consequences (social, environmental, economic) of water provision?
2.10. Are there any security issues related to people accessing water?

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2.11.	Has the location of the camp had any environmental impacts, especially with regards water availability, extraction, storage and use?
2.12.	Are sites of temporary shelter subject to occasional inundation? Is drainage adequate?
2.13.	Have measures been taken to ensure that drainage waters do not pollute surface or groundwater reservoirs?
2.14.	Do other sectors/activities contribute to water quantity/quality problems, e.g. agriculture or vector control?
2.15.	Identify possible impacts of water provisioning in the post-disaster and early recovery process.
2.16.	Other

### 3. Sanitation

3.1.	Have displaced communities been provided with adequate sanitation facilities?
3.2.	Do people avail of these facilities or is defecation taking place in open areas?
3.3.	Are current sanitation services adequate for the population? (Sphere standard is a maximum of 20 people per toilet.)
3.4.	Has the vulnerable component of the population been taken into consideration in the design and location of sanitation facilities?
3.5.	If household latrines exist have these been properly sited and constructed?
3.6.	If communal toilets are being used have effective measures been put in place to ensure personal security?
3.7.	Have people been consulted with regards then location and construction of latrines?
3.8.	Are there existing or threatened water and/or sanitation related diseases? If so, how are these being addressed?
3.9.	Have provisions been made to ensure proper water management (e.g. drainage) at water points to avoid standing water bodies?
3.10.	Is proper use being made with regards the storage, handling and disposal of any chemicals used for sanitation purposes?

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3.11.	Is ground water analysis being routinely carried out to ensure that there is no seepage from latrines into groundwater reservoirs?
3.12.	If additional latrines need to be constructed are there environmental implications?
3.13.	Are approved standards being used to deal with any human or livestock corpses?
3.14.	Have additional sites for burial been identified and screened from an environmental and health perspective?
3.15.	What are possible environmental implications for sanitation services and facilities during early recovery?
3.16.	Other

### 4. Waste Management

4.1.	What is/are the main source(s) of solid waste resulting from the disaster?
4.2.	Does any of this waste pose an immediate threat to people or the environment?
4.3.	Is there an estimate of the volume of the main types of waste (e.g. building rubble)?
4.4.	Has former waste management systems been impacted by the disaster? What needs to happen for them to be (come) effective?
4.5.	Are there identified waste disposal sites near the disaster affected area?
4.6.	Are medical wastes being separated and disposed of correctly?
4.7.	Are people who collect/handle waste provided with adequate and appropriate protective equipment?
4.8.	Do organisations providing relief generate an excessive amount of solid waste, e.g. packaging materials? If so, what is the main content?
4.9.	Have measures been taken to address, e.g. reduce, these? If so, are they adequate?
4.10.	Have plans been developed and put in place to encourage recycling?
4.11.	Is refuse being removed from temporary settlements before it becomes a health risk or nuisance?

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4.12.	Is disposed waste being treated to prevent insects and rodents being attracted to it, e.g. by proper burying?
4.13.	Have the environmental consequences of additional waste disposal sites been considered?
4.14.	Have livelihood and income-generating options been considered for waste collection and removal?
4.15.	What are possible environmental implications for waste management facilities and services during early recovery?
4.16.	Other

### 5. Energy

5.1.	Has the disaster had any obvious impact on the source(s) of energy commonly used by households or industry in the affected area(s)?
5.2.	What is/are the main type(s) of domestic energy being used by the affected communities? For what purpose (cooking, lighting, etc.)?
5.3.	What are the main sources of energy used by industry or small businesses, if different?
5.4.	Where are these materials sourced?
5.5.	Which, if any, of these is having a visible environmental impact?
5.6.	Has a plan been formulated to deal with the environmental consequences of this?
5.7.	If food relief is being provided, what are the main food items that require cooking? What form are these in (whole meal, milled, powdered...)?
5.8.	Are communities already familiar with fuel-efficient stoves?
5.9.	Are energy-efficient stoves being used? If so, by what percentage of the population?
5.10.	If fuel wood is the main source of domestic energy, has an assessment been conducted on the availability and needs for fuel wood? If so, what were the main observations and have particular concerns been identified?
5.11.	What is the average amount of fuel wood/ charcoal/kerosene being used per household per day?
5.12.	Are alternative fuel(s) available locally? If so, what would be required to

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introduce these to the camp?
5.13. Is there a security issue related to accessing energy sources such as fuel wood?
5.14. If fuel is being provided are appropriate systems in place to discourage resale and use of natural resources?
5.15. Has communal cooking been considered as an option to reduce the amount of energy required?
5.16. What are some of the possible environmental implications for energy during early recovery?
5.17. Other

### 6. Biodiversity

6.1. Are there known sites of ecological importance in or near the area impacted by the disaster?
6.2. Have management plans for such sites included disaster preparedness?
6.3. Are there known species or habitats at risk in this area, e.g. endemic species or vital ecosystem services?
6.4. Are national agencies responsible for managing natural resources and biodiversity conservation still functional after the disaster?
6.5. Has a damage assessment been carried out on any site of ecological value which may have been impacted by the disaster?
6.6. Were disaster risk reduction and management plans in place prior to the disaster?
6.7. Is there a possibility that the environment and key sites or biodiversity might be negatively impacted by temporary resettlement of disaster surviving communities?
6.8. Is there any link with pre-disaster environmental degradation and the current scale or impact of the disaster?
6.9. Is there evidence that some ecosystems might have had a positive influence?
6.10. What might some of the implications be on the region's biodiversity during early recovery?

6.11. Other

## **7. Agriculture, Livestock, and Fisheries**

7.1.	Were there formerly any environmental impacts related to agriculture, fisheries or livestock keeping in the affected area?
7.2.	Have the immediate impacts of the disaster on agricultural lands and livestock been assessed?
7.3.	Is the disaster known to have had an impact on coastal or inland fisheries?
7.4.	Was there formerly a strong dependence by communities on agriculture, livestock keeping or fisheries?
7.5.	What percentage of the population was engaged in these productive sectors?
7.6.	Which members of the community were formerly engaged in these sectors?
7.7.	Has the livestock carrying capacity of rangeland within the impacted area been affected?
7.8.	If livestock have been severely affected by the disaster, are veterinary facilities now available?
7.9.	Have any outbreaks of animal disease been detected, relating to the disaster? If so, what measures have been taken to control and deal with this?
7.10.	Have institutional extension services normally available to people engaged in farming/fishing been disrupted on account of the disaster?
7.11.	Has a needs assessment been conducted among farmers, livestock owners or fishermen (e.g. in terms of possible restocking)?
7.12.	What might some of the environmental impacts be of future development of the agricultural, farming and fisheries sectors during early recovery?
7.13.	Other

## **Annex 3**

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