Environmental Guidance Note for Disaster Risk Reduction

Healthy Ecosystems for Human Security

Karen Sudmeier-Rieux and Neville Ash

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The wellbeing of people all over the world depends on the various good and services provided by ecosystems, including food, fuel, construction material, clean water and air, and protection from natural hazards, Ecosystems, however, are under increasing pressure from unsustainable use and other threats including outright conversion. To address this concern, IUCN promotes the sound management of ecosystems through the wider application of the Ecosystem Approach - a strategy for the integrated management of land, water and living resources that places human needs at its centre. The aim of the IUCN Ecosystem Management Series is to support best practice ecosystem management, both at field and policy levels, to help realise IUCN's vision of a just world that values and conserves nature.

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This guidance note is based on the collective "wisdom" of published, unpublished documents and guidelines on ecosystems, environmental management and disaster risk reduction. We expect that further consultations will evolve into full guidelines with revised indicators in the upcoming year. We consider this "environmental guidance note" to be work in progress, yet based on a wide consultation with different IUCN programmes, commission members, technical experts and partnering organizations, notably with the UN/International Strategy for Disaster Reduction (UNISDR) Partnership for Environment and Disaster Risk Reduction (PEDRR), which benefits from the participation of the following organisations: Asian Disaster Preparedness Centre (ADPC), Global Fire Monitoring Center (GFMC), International Union for Conservation of Nature (IUCN), ProAct Network, Stockholm Environment Institute (SEI), World Wildlife Fund (WWF), United Nations Environment Programme (UNEP), United Nations University – Institute for Environment and Human Security (UNU-EHS). We would like to thank all persons who have provided suggestions, ideas and critiques of this document, especially Ilan Kelman (CICERO, Norway), Brian McAdoo (Vassar College, U.S.), Fabrice Renaud (UNU-EHS, Germany), Ali Raza Rizvi (IUCN-ELG2, Sri Lanka), Jonathan Randall (WWF), Lorena Aguilar (IUCN), Radhika Murti (IUCN) and Nina Saalismaa (ProAct Network). Special thanks to Glenn Dolcemascolo (UNISDR) and Carolin Schaerpf (UNISDR) for their support.

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Environmental Guidance Note for Disaster Risk Reduction

Healthy Ecosystems for Human Security

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Introduction: Human well-being, healthy ecosystems and disasters

This note was developed to provide guidance on the benefits of and ways **to integrate environmental concerns into disaster risk reduction strategies (DRR) at the local and national levels.** As recognised and outlined under the Hyogo Framework for Action priority 4: “Reduce the Underlying Risk Factors”, healthy ecosystems and environmental management are considered key actions in DRR. Although the field of disaster risk management has evolved to recognize the need for addressing development issues for reducing risk, the environmental dimension has not to date received adequate attention and practical guidance.

The questions we would like to answer with this guidance note are:

- **What are healthy ecosystems and ecosystem management?**
- **How can we integrate these environmental considerations into DRR?**

The rise in number and intensity of many extreme hydro-meteorological events is increasingly recognized as being the result of global and regional climate change. More broadly and importantly, the underlying risk factors of disasters are increasing: more people are living in vulnerable areas, such as low lying coastal areas, steep hillsides, flood plains, near cliffs, or in forested areas on the outskirts of cities – most often out of necessity, but sometimes out of choice. Environmental degradation is reducing the capacity of ecosystems to meet the needs of people for food and other products, and to protect them from hazards. The people affected by reoccurring disasters are often the most dependent on natural resources for their livelihoods, and the appropriate management of ecosystems can play a critical role in their ability to prevent, cope with, and recover from disasters.

Investments in sustainable ecosystem management or sound environmental management can offer **cost-effective solutions to reducing community vulnerability** to disasters. Healthy ecosystems, such as intact forests, wetlands, mangroves, and coral reefs are beneficial to local populations for the many **livelihood benefits** and products that they provide: firewood, clean water, fibres, medicine and food, while acting as **natural buffers to hazard events** for flood abatement, slope stabilization, coastal protection and avalanche protection, in addition to other structural and disaster preparedness measures. These natural buffers are often **less expensive to install or maintain, and often more effective than physical engineering structures**, such as dykes, levees, or concrete walls. The limited effectiveness of some physical engineering approaches has been dramatically demonstrated by disasters such as Hurricane Katrina in 2005 with the failure of the dyke system established to protect New Orleans. As a result, dams are being torn down and wetlands are being restored along the Mississippi basin to provide an ecosystem-based approach to DRR. The services provided by ecosystems are not an additional luxury, but rather a basic necessity to disaster risk reduction. We support shifting disaster risk management from reaction to prevention and placing sustainable ecosystem management for livelihoods at the center of disaster risk reduction strategies. **Balancing prevention with reaction requires political will**, donor willingness and new strategies, to which we hope this guidance note contributes.

Shelburne Bay,Great Barrier Reef Heritage Area, Australia

Ecosystems contribute to reducing the risk of disasters in multiple and varied ways. Well-managed ecosystems can reduce the impact of many natural hazards, such as landslides, flooding, avalanches and storm surges. The extent to which an ecosystem will buffer against extreme events will depend on an ecosystem's health and the intensity of the event. Degraded ecosystems can sometimes still play a buffering role, although to a much lesser extent than fully functioning ecosystems

Ecosystems are defined as dynamic complexes of plants, animals and other living communities and their non-living environment interacting as functional units (Millennium Ecosystem Assessment, 2005). They are the basis of all life and livelihoods, and are systems upon which major industries are based, such as agriculture, fisheries, timber and other extractive industries. The range of goods and other benefits that people derive from ecosystems contributes to the ability of people and their communities to withstand and recover from disasters. The term "sustainable ecosystems" or **healthy ecosystems**, implies that ecosystems are largely intact and functioning, and that resource use, or demand for ecosystem services does not exceed supply in consideration of future generations.

Healthy ecosystems are comprised of interacting, and often diverse plant, animal and other species, and along with this species and underlying genetic diversity, constitute the broader array of biodiversity. **"Biodiversity"** is the combination of life forms and their interactions with one another, and with the physical environment, which has made Earth habitable for people. Ecosystems provide the basic necessities of life, offer protection from natural disasters and disease, and are the foundation for human culture (Millennium Ecosystem Assessment, 2005).

BOX 1

According to the World Bank (2004), investments in preventive measures, including in maintaining healthy ecosystems are seven-fold more cost effective than the costs incurred by disasters.

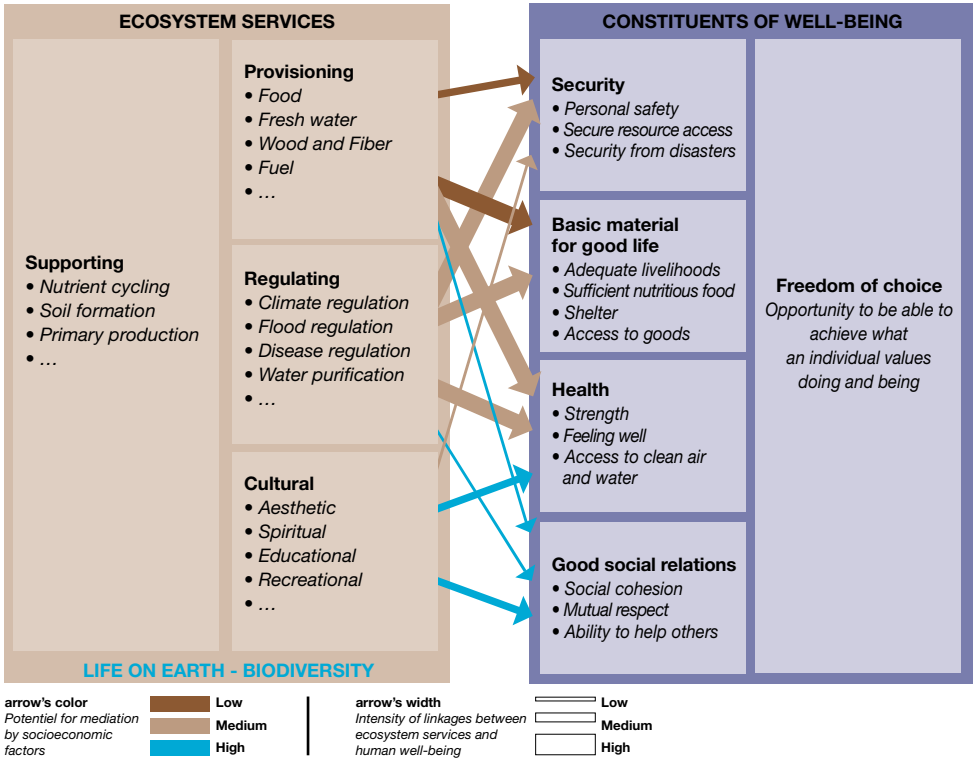

Figure 1. Ecosystem services and human well-being (Millennium Ecosystem Assessment, 2005)

The benefits that people derive from ecosystems, or "ecosystem services" are often categorised into four types:

- **Supporting services:** these are overarching services necessary for the production of all other ecosystem services such as production of biomass, nutrient cycling, water cycling and carbon sequestration.
- **Provisioning services:** these are the services we often consider as "ecosystem goods" and products obtained from ecosystems to support livelihoods such as food, fibre, genetic resources, medicines, fresh water.
- **Regulating services:** these are the services that offer protection and otherwise regulate the environment in which people live, such as flood regulation, water filtration, pollination, erosion control, disease regulation.
- **Cultural services:** these are services supporting spiritual values, aesthetic, educational and recreational needs.

(Millennium Ecosystem Assessment, 2005)

BOX 2

Degraded ecosystems reduce community resilience for sustainable development as well as disaster preparedness and recovery.

Pakistan earthquake and landslides, 2007

The Millennium Ecosystem Assessment (MA), a five-year international assessment initiative, clearly demonstrated the strong and varied links between human well-being, human security, livelihoods, health and intangible benefits such as equality and freedom of choice, with ecosystem services. The MA also highlighted that ecosystem degradation is undermining this link due to a number of human activities, mainly:

- **over-exploitation of resources** or higher demand for ecosystem goods than can be sustained, such as overfishing;
- **land use and land cover changes,** or changes to habitats due to conversion to croplands and urbanization;
- **climate change impacts** are affecting ecosystems and exacerbating environmental degradation;
- **invasive alien species** are introduced species that compete and encroach vigorously upon native species, with the potential to degrade ecosystem services and cause severe economic damage;
- **pollution,** from chemical waste and agricultural inputs has severely degraded many ecosystem services, and continues to act as a major driver of change.

(modified from Miththapala, 2008)

Ecosystem degradation and loss have led to serious impacts on human well-being: these include reduced availability of goods and services to local communities, increased spread of diseases and reduced economic opportunities. This, in turn, is leading to loss of livelihoods, and reduced food security (Miththapala, 2008.)

Healthy ecosystems both reduce vulnerability to hazards by supporting livelihoods, while acting as physical buffers to reduce the impact of hazard events. As such, this "natural infrastructure" is in many cases equally effective in reducing the impact of hazard events, and are often less expensive than human-built infrastructure. Disasters also hamper development goals, and yet few governments, donors and development organizations adopt a precautionary approach in the design and management of projects, and fewer still recognize the role and value of ecosystem management for reducing disaster risk (UNEP, 2007).

….and why do they matter to disaster risk management?

Five reasons why ecosystems matter to disaster risk reduction:

- **Human well-being depends on ecosystems** that enable people to withstand, cope with, and recover from disasters. Disaster-resilient communities, especially in rural areas, are based on healthy ecosystems and diverse livelihoods;

- **Ecosystems, such as wetlands, forests, and coastal systems can provide cost-effective natural buffers** against hazard events and the impacts of climate change. According to the World Bank (2004), investments in preventive measures - including in maintaining healthy ecosystems is seven-fold more cost effective than the costs incurred by disasters;

- **There are clear links between resource degradation and disaster risk.** Degraded ecosystems are unable to provide the benefits that help communities to reduce their vulnerability to disasters. In addition, many disasters are caused by reoccurring conflicts, which are based on competition for scarce natural resources – and once a conflict has started it can also lead to additional environmental degradation;

- **Healthy and diverse ecosystems are more robust to extreme weather events.** Disasters can affect biodiversity through the spread of invasive species, mass species mortality, loss of habitat and poorly designed post disaster clean-up efforts. This may have a negative impact on progress toward achieving the objectives of the Convention on Biological Diversity[1] and Millennium Development Goals;

- **Ecosystem degradation reduces the ability of natural systems to sequester carbon**, exacerbating climate change impacted disasters.

[1] The Convention on Biological Diversity (CBD) has three objectives, of the conservation of biodiversity, the sustainable use of its components, and the equitable sharing of benefits from the use of biodiversity. In 2002, the CBD adopted the 2010 Biodiversity Target, to reduce the rate of loss of biodiversity by 2010. The 2010 target was subsequently endorsed at the World Summit on Sustainable Development, and has been incorporated into the Millennium Development Goals, as a target under MDG7 on environmental sustainability.

Mamberamo River, Papua Indonesia

BOX 3

An analysis of 141 countries in the period 1981 to 2002 found that disasters (and their subsequent impacts) on average killed more women than men, or they killed women at a younger age than men in societies where women's economic and social rights are not protected (Neumayer and Plumper, 2007).

Climate change and disaster events are creating greater population vulnerability, especially among women and children. This is due to slow creeping **environmental degradation**, populations living in more exposed areas, more frequent or more intense (or higher magnitude) extreme weather events and the social and governance factors that affect livelihoods. Disasters are mainly social constructs: they are largely determined by **how a society manages its environment**, how prepared it is to face adversity and what resources are available for recovery. Vulnerable populations are more at risk to natural disasters – those in rural areas are also heavily dependent on ecosystem services for their livelihoods and for physical protection. Therefore, investing in ecosystems and mainstreaming disaster risk and ecosystem management in development planning is likely to make a major contribution to the goal of achieving sustainable livelihoods for the poor.

BOX 4

Broadly defined, the total economic value of ecosystems includes:
Use values
- **Direct values: benefits derived from the use of environmental goods either for direct consumption or production of other commodities**
- **Indirect values: benefits provided by ecosystem functions and services that maintain and protect natural and human systems such as maintenance of water quality and flow, flood control and storm protection.**
- **Option values: the premium placed on maintaining an ecosystem service (i.e. a pool of species, genetic resources and landscapes) for future uses**

Non-use values
- **Bequest value: the willingness to pay to ensure that future generations inherit a particular environmental asset and**
- **Instrinsic value – i.e. the value of biodiversity in its own right independent of value placed on it by people.**

(Emerton and Bos, 2004)

How can ecosystems contribute to reducing disasters?

Examples and values of protective ecosystem services:

Regulating flood waters

BOX 5

Declining ecosystems are increasing the vulnerability of people to disasters and their inability to absorb related shocks and stresses (Emerton, 2006).

Wetlands and peatlands provide storage space for flood waters, and there is growing evidence that maintaining vegetation and associated soil structure in local watersheds regulates the flow of rain water into streams and rivers, although this service can be overwhelmed with large-scale rainfall and flooding events. Sri Lanka's Muturajawla marsh is a coastal peat bog covering over 3,100 hectares and an important part of local flood control as the marsh buffers and regulates flood water discharge into the sea. The annual value of this service was estimated at more than $US 5 million, or $US 1,750 per hectare (Emerton and Bos, 2004). Riparian and coastal vegetation also stabilizes shorelines and riverbanks. The costs of losing vegetation along riverbanks has been estimated at up to $US 425 per meter of bank (Ramsar Convention on Wetlands, 2005).

Reducing landslides, avalanches and rockfalls

In addition to providing improved aesthetics over engineering structures, forests are estimated to save between $US 2-3.5 billion per year in disaster damage (UNISDR, 2004). Switzerland, for example, long ago recognized the value of 'protection forests' in reducing damage from avalanches, landslides and rock falls, and forests are a key part of the country's disaster prevention plan (Stolten et al., 2008). Healthy forests are less likely to be invaded by pests, invasive alien species and destroyed by natural hazards, and provide numerous additional benefits such as the storage of carbon, and the opportunity for recreation, timber production and non-timber products.

Improving coastal management and flood risk reduction

Intact coastal ecosystems - in particular mature, stabilized sand dunes, coral reefs, lagoons, salt marshes, and mangroves - play an important role in reducing flood damage during coastal storms (UNEP-WCMC, 2006). Coastal ecosystems are particularly effective in reducing flooding from small and medium–scale events. In addition to reducing coastal flooding, mangroves provide many other services, such as nursery habitat for fish and other marine species, firewood, building materials and medicine which support the needs of communities for both disaster risk reduction and development (ProAct Network, 2008).

Drought, Sand Storm and Fire regulation

Wildfires, wind erosion, severe drought are expected to increase worldwide as a result of climate change-induced weather changes. Wind erosion causes severe loss of topsoil, estimated at 161 tons of lost soil annually in Canada alone, and causing significant economic losses (ProAct Network, 2008). Ecosystems can act to buffer the processes of drought and desertification through shelterbelts, greenbelts, hedges and other "living fences". These buffers help break the force of winds, provide shade, stabilize dunes,

maintain soil structures, trap water and restore organic material, rendering soil more favorable to agricultural practices. Fire is a natural part of many ecosystems, and can enhance vegetation by controlling invasive plants and enhancing regenerative processes, especially in grazing lands. Where a reoccurring feature, fire is best managed as a part of agro-ecosystems, creating firebreaks, and controlling understory vegetation (Goldammer, 1988; ProAct Network, 2008; Stolten et al., 2008).

BOX 6

On the Cost Effectiveness of Ecosystems as Natural Buffers to Coastal Protection in Indonesia

Along Indonesia's coastlines, the value of marine and coastal ecosystems in decreasing vulnerability to risks and disasters accrue mainly through damage costs avoided – and these averted losses are typically substantial. A study in Bintuni Bay, West Papua, valued mangroves at US$600 per household per year based on their ability to control erosion.

A variety of values have been calculated for the coastal protection functions of coral reefs in Indonesia, depending on their location: reefs adjacent to sparsely populated areas where agriculture is the main activity have been valued at US$829/km (based on the value of agricultural production that would be lost), reefs adjacent to areas of high population densities at US$50,000/km (based on the cost of replacing housing and roads), and reefs in areas where tourism is the main use at US$1 million/km (based on the cost of maintaining sandy beaches). In total, Indonesia's coral reefs are estimated to have a value of some US$314 million for coastal erosion prevention.

When marine and coastal ecosystems are degraded and these important coastal defense functions are lost, high economic costs arise. The value of coastline protection by coral reefs in Wakatobi National Park has been estimated to be worth $473/km. The damage caused to reefs as a result of coral mining in Lombok is calculated to incur net present costs of between US$12,000-260,000/km² in terms of the resulting increase in coastal erosion. One hotel in West Lombok has spent US$880,000 over a seven-year period to restore a 250 m stretch of beach which had been damaged by past coral mining, and more than US$1 million has been spent in Bali to protect 500 metres of coastline that is no longer protected by coral reefs.
(Emerton, 2009)

Ecosystem management is central to building resilience of communities and nations under the Hyogo Framework for Action, especially HFA priority 4.

Mangroves, providing spawning grounds for numerous fish species, Sri Lanka

Therefore, ecosystem-based disaster management policies, practices and guidelines need to be an integral part of national disaster risk reduction. Ecosystem-based disaster management refers to decision-making activities that take into consideration current and future human livelihood needs and bio-physical requirements of ecosystems, and recognize the role of ecosystems in supporting communities to prepare for and cope with disaster situations.

Sprats, Sri Lanka

This is of particular relevance to the field of disaster risk management as it is a meeting point for enhanced livelihood security for the poor and long-term management of ecosystems. It is a strategy consistent with the Ecosystem Approach of the Convention on Biological Diversity, for the integrated management of land, water and living resources for human benefits as well as conservation goals (See Annex 1). Ecosystem-based DRR recognizes that ecosystems are not isolated but connected through the biodiversity, water, land, air and people that they constitute and support (Shepherd, 2008). Sustainable ecosystem management is based on equitable stakeholder involvement in land management decisions, land-use trade-offs and long-term goal setting. These are central elements to reducing underlying risk factors for disasters and climate change impacts[2].

[2] *See "Ecosystem-based DRR" (www.iirr.org)*

BOX 7

Indonesia takes steps to integrate environmental and disaster risk reduction policies

Recognizing Indonesia's vulnerability to hazard events and disasters, the 2006-2009 National Action Plan for Disaster Risk Reduction was launched. This important document (also backed up by legislation via the Disaster Management Law No. 24 of 2007) makes repeated mention of the importance of ecosystems and a healthy environment in disaster risk management and reduction. Ecosystem degradation is recognized as one of the major factors, which interact to cause disasters, and the Plan itself includes a series of actions to encourage the sustainable use and management of ecosystems. It demands that "Regions that depend themselves on extractive industry and exploitation of natural and environmental resources are expected to equally invest on the efforts of mitigation, preparedness, response and recovery from disaster impacts that have been or may be caused by those activities". The plan specifically calls for natural resource protection and zoning in coastal and sea areas.
(Emerton, 2009)

How can ecosystem management be integrated with disaster risk management?

Although disaster risk management, ecosystem management, development planning (and climate change adaptation) institutions each have their own specific set of stakeholders, goals and actions, a number of these are interrelated (see Figure 2). They each seek the overarching goal of sustainable development, human well-being and human security. Improved dialogue and specific coordinating mechanisms are being created between these spheres, although more effort is needed to achieve greater convergence. Likewise, conservation programmes can benefit by including risk and climate change considerations into project planning and monitoring. Below are examples of specific actions that can be taken toward bridging the gap between ecosystem-based management and disaster risk management.

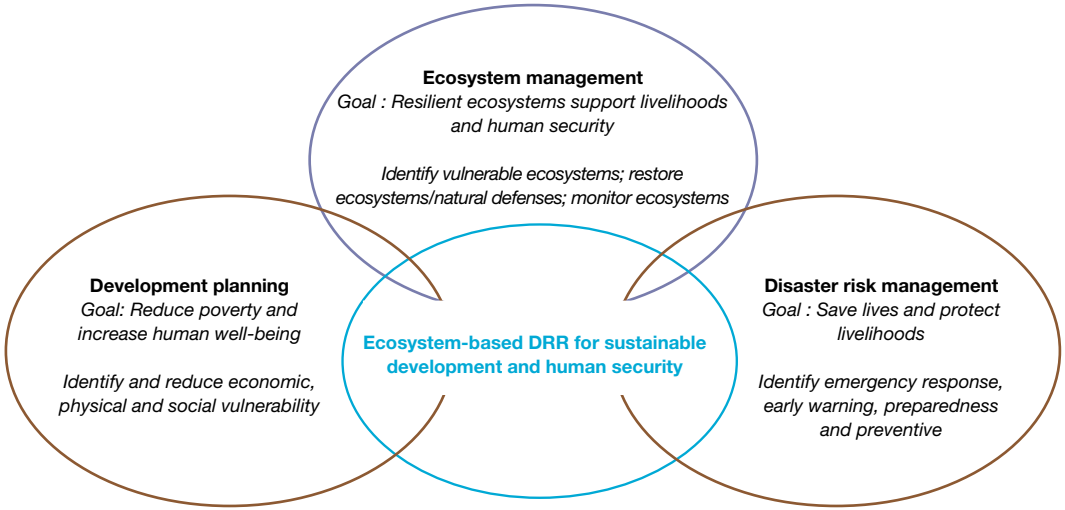

Fig. 2 Ecosystem-based disaster risk reduction, a more sustainable approach to DRR and climate change adaptation

BOX 8

Three previously separate institutional spheres need to converge to form new procedures for integrated disaster risk management. Ecosystem management becomes central to all aspects of disaster risk reduction, without which goals of human security, sustainable development and climate change adaptation cannot be achieved.

Prioritizing ecosystem-based DRR

Many countries have already recognized the need for legislation and zoning regulations that support sustainable development and environmental principles. However, where legislation often fails is in the implementation and enforcement, leading the way for unsustainable and risk-building practices, such as locating housing in dangerous places. Policies and financial incentives can be offered for investing in ecosystem protection, such as "Payments for Ecosystem Services", or through new carbon market and other schemes such as REDD[3], which aim to reduce environmental degradation. Incorporating environmental concerns into contingency plans for disaster response is intended to follow the principles of "do no harm" to long-term recovery (i.e. improper waste management practices that pollute waterways, or locating transitional shelters and settlements in floodplains or elephant pathways) and aim to rebuild back better.

Appropriate National and local governance and policies:

- **Recognize the value of ecosystems** as necessary for disaster risk reduction;
- **Grant relevant legal authority** to environmental, planning and disaster management agencies to coordinate and enforce sustainable environmental DRR policies and procedures;
- **Seek to** integrate national adaptation processes, such as NAPAs with DRR and environmental national strategies.
- **Encourage new financial incentives** for investments in sustainable ecosystem management that emphasize ecosystems as part of disaster risk planning, possibly financed through payments for ecosystem services;

Implementing environmental monitoring and enforcing sustainable land use planning

Progress can be made by integrating land use planning and environmental monitoring into disaster management such as maintaining wetlands for flood risk reduction. Environmental monitoring implies maintaining baseline data on ecosystem health and tracking trends in environmental degradation, such as deforestation and drought, and restoration. Integrated risk assessments can be designed as a useful tool to couple physical risk, vulnerability and environmental assessments. They go beyond the Environmental Impact Assessment (EIA) and Strategic Environmental Assessment (SEA) processes, which are conducted for new development projects.

Integrated mechanisms and procedures are useful to:

- **Promote and enforce integrated land use (spatial and temporal) planning and zoning** that include protection of ecosystems (e.g. Integrated Coastal Zone Management, Integrated Water Resources Management, and forest management plans) and risk assessments.
- **Conduct environmental monitoring and assessments** (ecosystem baseline data, EIAs, SEAs for new development projects and programmes);

[3] *REDD: Reducing Emissions from Deforestation and Degradation in Developing Countries*

- **Conduct integrated risk assessments** (coupling physical risk, vulnerability and environmental assessments);
- **Implement ecosystem restoration and rehabilitation** that follow clear technical guidance and match local needs and priorities;
- **Incorporate environmental safeguards** into disaster emergency response plans, such as Rapid Environmental Assessments (see checklist below);
(Modified from UNEP, 2009)

BOX 9

Payments for Ecosystem Services
These financial mechanisms are increasingly being used successfully to finance ecosystem conservation and restoration. Examples include payments to a community to maintain forest cover in sensitive water recharge areas, or on steep slopes to reduce the occurrence of landslides or downstream flooding.

The beneficiary community or other third party would pay for the benefits incurred.
(IUCN-UNEP 2007)

Engaging with stakeholders

Ecosystem management practices are the most successful when they involve communities as stakeholders and land stewards, such as community-managed marine protected areas, or community forest user groups. These environmental mechanisms can become especially relevant and effective for disaster risk reduction if they incorporate disaster risk assessments. To achieve this, there is a need to put into place mechanisms for consultations between environmental, planning and disaster management authorities. It is important to:

- **Build dialogues** and mechanisms for collaboration between environmental, planning and disaster risk management authorities and people affected by the decisions;
- **Include communities**, especially women, minorities, and people with disabilities in designing and implementing the above procedures.

Knowledge creation and exchanges

Capacity-building through awareness-raising, education and training are critical to changing attitudes and behaviors toward more sustainable environmental practices. As an example, ecosystem rehabilitation and restoration can be options in the aftermath of a disaster or to safeguard against new ones. However, successful ecosystem rehabilitation requires time, knowledge, resources and should be conducted in consultation with communities, appropriate technical advice, and based on local needs and priorities especially when natural restoration may be the most effective option.

Awareness raising, education, training and knowledge exchange can help to:

- **Promote new knowledge** creation and sharing among scientists, practitioners and communities;
- **Recognize the value of local practices and knowledge;**
- **Recognize the special role that women play** as agents of change and stewards of natural resources and as being highly affected by extreme events.

BOX 10

5 years after the Indian Ocean tsunami - lessons learned from Sri Lanka

- **Beach clean-up efforts led to the spread of invasive species, notably prickly pear *(Opuntia humifusa)*;**
- **Dumping of debris from the cleanup into waterways and wetlands created pollution and drainage problems that hampered long-term recovery;**
- **Several transitional settlements were located in elephant pathways and near waterways, creating animal-human conflict and pollution of drinking water;**
- **In some instances, sand dunes and coral reefs that protected coastal communities from the tsunamis' full impact were used for building materials, thereby reducing coastal protection;**
- **Better coordination and information flow between environmental authorities, NGOs and disaster management authorities could have avoided several of these pitfalls;**
- **Women died and were affected in much larger numbers, likely due to restricted clothing and lack of swimming skills;**
- **Boats were improperly distributed post-tsunami, creating social tension and lasting development problems;**
- **Mangrove restoration efforts have largely failed due to improper planting procedures, lack of community involvement, and planting in the wrong places;**
- **A positive outcome of lessons from the tsunami is the "Sri Lanka Road Map" for disaster risk management, which includes several provisions for integrating environmental considerations into disaster risk reduction planning and operations.**

(Modified from Miththapala, 2008)

Pre-disaster:

- Prevention, mitigation and preparedness stages should ensure that proper **environmental practices are followed that value and restore ecosystems**, especially wetlands, coastal ecosystems and forests on steep slopes as natural buffers. Specific projects may include wetland restoration, tree planting, and restoring coastal open spaces.

- Disaster risk reduction planning should include **coordination with environmental ministries**, in addition to disaster management and land use planning authorities.

Bururi Province, Burundi

- Ensure that existing legislation is being followed and enforced, especially related to **zoning and land-use planning**, for example respecting coastal buffer zones and proper road building in mountainous areas to avoid landslides; and ensure that land use planning **is not damaging to ecosystems and human well-being**.

- **Conduct education and training about the role of ecosystems** and their multiple benefits for protection and human well-being.

Post-disaster:

- Response, recovery and rebuilding stages progress from quick relief to save lives to short and medium-term planning of lodging and livelihood solutions. Basic environmental **concerns must be integrated into each of these stages**, following the goal of "reducing the underlying risk factors". Basic environmental considerations can be included in contingency plans and standard disaster response procedures in order to avoid potential damage that can be incurred and impede long-term recovery.

- **Minimise pollution and make waste management effective**; ensure that waste does not contaminate waterways or wetlands areas and hazardous waste materials are secured;

- **Locate transitional shelters and settlements[4] away from sensitive ecosystems** and from areas that may put people in harms way (such as floodplains, wetlands and animal habitats) while providing adequate sanitation facilities;

- **Take care that building materials are sustainably sourced** (e.g. not mining coastal sand dunes, mangroves, or coral reefs to rebuild houses);

[4] *For more information see: (www.sheltercentre.org)*

- **Rehabilitate damaged ecosystems with native species and prevent the spread of invasive alien species**; these are non-native species that can invade habitats and agricultural land.

- Special provisions should be made for women, children and other vulnerable populations, according to Sphere Handbook charter[5].

- **Rapid Environmental Assessments[6]** are useful to assessing the environmental situation post-disaster in a quick and low cost manner for more effective immediate and long-term recovery planning. (Modified from Miththapala 2008)

BOX 11

Key actions for ecosystem-based DRR:

Watersheds, forests and coastal zones are naturally linked – for example without adequate upstream forest cover, sedimentation can create severe downstream pollution and damage to coastal vegetation and coral reefs.

Watershed management
Watershed management is necessary for agricultural, environmental, and socioeconomic development. The physical and biological resources of watersheds provide goods and services to people, including water protection, attenuation of disasters by regulating runoff, protection of coastal resources and fisheries, protection of the environment and protection of productive lowlands. Watershed management programs need to build on existing environmental initiatives.
- **When located in floodplains, structures should be built to withstand flood damage, to prevent floodwater contamination, and to avoid disruption to river courses, river banks and vegetation;**
- **Intensive agricultural activity should not to be permitted on slopes greater than a specified percentage reflecting land stability;**
- **Clear cutting of forests should be limited with forest conservation and sustainable forest management prioritised;**
- **Institutional bodies, such as River Basin Organisations should be formally established to address land use conflicts, and staff trained in conflict-resolution;**
- **Public participation of both men and women should be increased in management decisions;**
- **Effective management plans and enforcement of environmental and zoning regulation are critical;**
- **Regional environmental impact assessments are needed to ensure that cumulative impacts of economic activities are sustainable.**

Forest management
Forest management is required to balance demand for forest products with the ecological requirements of forests, while ensuring other key benefits for livelihoods, notably by stabilizing steep slopes and reducing soil erosion. Although listed separately here, forest management is often integrated into watershed management.
- **Protect and improve the forest environment through increased vegetation;**
- **Help alleviate poverty by generating income through increased tree cover and related activities;**
- **Increase forest resources;**
- **Establish community-driven economic activities based on forest plantation;**
- **Increase multiple uses for land; and**
- **Create popular awareness about sustainable forest management.**

Coastal zone management
Ecosystems such as coral reefs and coastal mangrove forests can adapt to change and recover from storms and floods and still provide services of protecting the coast and absorbing pollution. But once these ecosystems are put under pressure by coastal development, they may lose their resilience. Coastal zone management strategies being considered in the Asia-Pacific region after the 2004 tsunami highlighted the continuum of inland areas, coasts, and oceans. Below are some key entry points.
- **Replant coastal forests and restoration of mangroves, which have been taken up as a part of the environmental recovery process.**
- **Restore and maintain the health of the coral reefs and seagrass beds.**
- **Maintain and/or develop mangrove belts as buffer zones for coasts and coral reefs.**
- **Protect wetlands and watersheds to minimize sedimentation.**

(Modified from DEWGA, 2008)

© R McWilliam 2005

An island village, Fiji

[5] *(www.sphereproject.org)*
[5] *(www.abuhrc.org)*

Post tropical storm Stan, Guatemala

Responding to tropical storms and flooding in Guatemala / Mexico

In the high-altitude upper watersheds of the Coatán and Suchiate rivers, straddling the borders of Guatemala and Mexico, and flowing off the slopes of the Tacaná volcano to the Pacific Ocean, environmental degradation and climate change are raising the risk of devastating flash floods.

These watersheds have been deforested and are badly degraded in many places. Severe erosion of formerly deep soils has reduced their capacity to hold water. Population density is high and degradation of the environment has limited people's livelihood options. Communities are therefore increasingly vulnerable to flooding caused by tropical storms and hurricanes.

In 2005 tropical storm Stan dropped torrential rains in the region, causing 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. This 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 into 'micro-watershed councils' to coordinate watershed management among groups of villages. People have become aware of the effects of unsustainable environmental management. They have identified the different demands on water and defined priorities for managing and restoring watersheds that responds to their development needs.

Driven by the need to expand their livelihood options to reduce poverty, these community councils have led to diversification of farming systems, including terracing of degraded slopes and reforestation through the introduction of agroforestry. Communities are investing their labour and capital in restoration of natural infrastructure. As self-organisation expands, communities are becoming better equipped to adapt to climate change and less sensitive to severe storms.

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

Smith, D.M. and Barchiesi S, 2009. Environment as infrastructure – Resilience to climate change impacts on water through investments in nature. In: Perspectives on water and climate change adaptation. CPWC, World Water Council, IUCN and IWA
Available at:
http://www.waterandclimate.org/index.php?id=5thWorldWaterForumpublications810

Using indigenous techniques to reduce disaster risks, reverse land and water degradation and improve livelihoods – traditional agroforestry on hillsides in Honduras

In remote villages of hilly southwest Honduras, local farmers have an age-old trick to protect their crops from hurricanes. Thousands of resource-poor farmers have readopted and adapted traditional farming techniques which have substantially improved their livelihoods and provide them with multiple benefits and at the same time successfully reduced impacts of natural disasters.

Lempira, Honduras

The traditional farming methods have proven a high degree of resilience to extreme weather events such as severe droughts and extreme rain during el Niño and la Niña events. When the disastrous hurricane Mitch went almost directly over the villages in 1998, there was very little evidence of destruction in the region, while elsewhere eroded soil and rocks crashed into houses and roads.

The explanation for this success story is an ecosystem-based farming system called "Quesungual Slash and Mulch Agroforestry System (QSMAS)". It is based on local traditional knowledge and improves an indigenous method which was conserved by a small group of farmers in a village called Quesungual. In the early 1990s a project by the central government, in collaboration with the UN Food and Agricultural Organization (FAO) office, rediscovered and promoted the traditional Quezungal method. This involves planting crops under dispersed native trees whose roots anchor the soil. Vegetation is pruned to keep competition to a minimum, provide nutrients to the soil and conserve soil water, while terracing reduces soil erosion. The crops are directly planted without burning and with zero tillage, which permanently keeps the soil cover and protects the soil from raindrop impact and crust formation while minimizing surface evaporation.

Based on a holistic approach, local perspectives and a participatory, collaborative community-based learning process, the QSMAS project not only led to reduction of disaster risks, but also proved to be an entry point for a successful integrated development strategy with multiple concrete benefits from farm to landscape level.

Sources:
FAO, Rome Mr Luis Alvarez Welchez, Agroforestry expert at the FAO Lempira Extension System Project (SEL), Lempira, Honduras. http://www.bbc.co.uk/mundo/participe/2009/05/090515_participe_cambio_climatico_quesungual_am.shtml

Fernández, Liliana and Edgardo Navarro. 2005. «El Sistema Agroforestal Quesungual: Una opción para el manejo de suelos en zonas secas de ladera». Sistema de Extensión Lempira (SEL). Tegucigalpa, Honduras: FAO.

Fishermen, Muthujarawela Marsh, Sri Lanka

Protective Effects of Coastal Vegetation during the 2004 Tsunami in Sri Lanka

The tsunami in December 2004 hit large parts of the Sri Lankan coastline. In addition to more than 30,000 fatalities the waves also affected valuable coastal ecosystems such as lagoons, mangroves, and salt marshes. To check the hypothesis that coastal vegetation saved lives by reducing the energy of the waves, a survey was carried out in Balapitiya, a densely populated town at the south-western Sri Lankan coast. In the hinterland of the town there is Maduganga Estuary, which is connected to the sea through a narrow inlet just south of Balapitiya.

In addition to detailed household surveys, coastal vegetation was mapped along a length of 1.7 km of coastline, together with the damage classes of the surveyed houses (up to distance of 300 m from the shoreline) and the water level at the houses, which was reported by the respondents. Vegetation was a mixture of Pandanus (screw pines), coconut palms, and various shrubs. After dividing the mapped vegetation into three classes depending on their composition, statistical analyses (linear regression) showed that the buffering effect of the class without Pandanus was significantly lower compared to the other two classes. Distance of the houses to the sea was also taken into account. The analyses further revealed the channelling effect of the inlet, as many houses along the inlet were completely destroyed. The small mangrove strips in front of the houses did not provide any protection in this case, as they were too narrow to reduce the destructive force of the waves significantly.

The study showed on a local level that coastal vegetation has the potential to buffer the impacts of tsunami waves and protect lives and property, with the composition of the vegetation being a very important factor. However, results of this study are only transferable to similar situations, and further confounding factors should also be considered. It also revealed that particular attention should be paid to water bodies connected to the sea, which might be dangerous places due to channelling effects. In this case, any vegetation buffer must have a certain width and composition to provide reliable protection.

Source:
extract from a paper submitted to Natural Hazards and Earth System Sciences: Kaplan, M.; Renaud, F.G.; Lüchters, G. (2009): Vulnerability Assessment and Protective Effects of Coastal Vegetation during the 2004 Tsunami in Sri Lanka.

United Nations University, Institute for Environment and Human Security, Bonn; University of Bonn, Center for Development Research, Germany

Reducing fire disasters through ecosystem management in the Mediterranean

Forest fires, Andket, Akkar Lebanon

Fire is the main cause of forest loss in the northern Mediterranean, with considerable impact on properties and livelihoods. An average of over 400,000 ha is burnt each year, with a massive 751,798 ha burnt in 2003 alone. National strategies allocating major efforts and resources to fire fighting (i.e. buying of hydroplanes and helicopters) have proved to be inefficient in the light of the growing trend of large-scale devastating fires. An integrated fire management strategy should be based on a risk reduction management framework aiming to increase ecological and social resilience to adapt to the complex interrelation between the predicted increase of heat waves and the human-induced impacts on natural ecosystems.

In April 2008, IUCN, WWF, FAO and other regional IUCN members and partners agreed on a common position – the Athens Statement - for climate change adaptation in Mediterranean forest conservation and management, with a special focus to increase resilience to major disturbances.

A new forest fire strategy was adopted in Lebanon through a participatory process with the Lebanese government, and incorporating a climate change adaptation goal: “Reducing the risk of intense and frequent forest fires whilst allowing for fire regimes that are socially, economically and ecologically sustainable”. IUCN is supporting pilot actions to start implementing the new national strategy, mainly looking at building ecological and social resilience to climate change impacts in high fire risk landscapes, by:

- Developing a participatory planning process to design landscape patterns resilient to fire, and prevent land use changes which may alter their traditional mosaic structure and increase fire risk (i.e. the current trend of intensification of pine plantations).
- Identifying fuel reduction opportunities through traditional and innovative land uses (i.e. promoting livestock grazing in high fire risk areas).
- Developing and exploring opportunities to help adopt fire resilient land uses and landscape patterns (i.e. innovative management systems, economic incentives, etc).
- The ecological restoration of healthy forest conditions diversifying forest land with a higher number of native re-sprouting species, which regenerate better after fire.
- Preventive forest practices and fuel management aiming at reducing high forest fuel litter and the landscape susceptibility to fires.

Source:
Regato P (2008) Adapting to Global Change - Mediterranean Forests., IUCN-Med. and IUCN Regional Office for West Asia

Guidance indicators for sustainable environmental management related to disaster risk reduction and climate change adaptation

Flood in Shagarab, Eastern Sudan

Guidance indicators for sustainable environmental management related to disaster risk reduction and climate change adaptation

What are indicators?

The term "indicators" refers to data of a quantitative or qualitative nature which can provide and communicate scientifically robust measures of the status or change in condition. They indicate the current status and any changes in a process or a system with respect to a given aspect of interest. An indicator is a pointer. It can be a measurement, a number, a fact, an opinion or a perception that points to a specific condition or situation, and measures changes in that condition or situation over time. Indicators facilitate a close observation about the results of initiatives or actions, and help to simplify the presentation of complex situations. They are very important tools to evaluate and follow up DRR processes, and are valuable tools to help achieve better results in projects or initiatives. A good indicator is considered SMART (Specific, Measureable, Achievable, Relevant and Timely.)

Several types of indicators

Qualitative indicators are measures that refer to qualities. They deal with aspects that are not directly quantifiable, opinions, perceptions or judgments from people about something, such as people's reliance on their boats as an instrument of economic independence. On the other had **quantitative** indicators are measures that directly refer to numbers or amounts, such as the number of women who own boats in a community. Each type of indicator - qualitative and quantitative - expresses different, complementary, needed dimensions about the situation of interest (modified from Aguilar, 2009).

Progress or results indicators convey whether tangible results are being achieved, and **process indicators** indicate about the state of a process, such as stakeholder dialogue. The difference between the two may be time dependent. For example, a training workshop on environmental legislation and DRR in the short term may lead participants to attitude changes among participants and a process toward new legislation may be undertaken. Real progress resulting in new legislation and implementation mechanisms may take much longer and is dependent on other factors although the impetus may have come from the initial workshop.

Purpose and caveats of the suggested "Indicators for Ecosystem-based DRR"

We have developed these indicators to offer guidance on example areas to focus policy and resources in order to make progress on achieving HFA priority 4, "Reduce underlying risk factors" and in particular, "Sustainable ecosystems and environmental management". The indicators are both qualitative and quantitative, and mainly process-oriented. Caveats of the proposed (and any) indicators are multiple. They need to be configured to the local context in order to become SMART; they are not universal; they will not always apply to all countries, at all scales; they may not adequately reflect cultural considerations and specific contexts. However, the following list of indicators is intended to provide guidance for integrating ecosystem management into disaster risk reduction policies and practices, a dimension that has not received adequate attention and practical guidance to date.

The suggested indicators can be used for further defining and refining nationally and locally relevant indicators. They have also been classified according to disaster risk management, vulnerability related, policies, operational mechanisms, knowledge and education, human well-being, ecosystem services, drivers of threats to ecosystem services and characteristics of disaster-resilient communities.

Important work has already been conducted in developing and testing relevant indicators for sustainable development and human well-being, ecosystem health, ecosystem services, disaster management. We have drawn upon many of these sources (see section "Resources") to develop this list of indicators relevant to ecosystem-based disaster risk reduction.

Examples of indicators for use in ecosystem-based disaster risk reduction	
1.	**Risk Identification Indicators**
1.1	Systematic inventory of disasters and losses
1.2	Hazard monitoring and mapping
1.3	Vulnerability and risk assessment
1.4	Monitoring of ecosystem conditions, ecosystem services and threats to ecosystems
2.	**Policy indicators linking ecosystem-based management to DRR**
2.1	National platforms for DRR, HFA focal point and other national disaster risk institutions include environmental and planning ministries in decision-making and implementation
2.2	Legislative mechanisms effectively incorporate sustainable land use planning into DRR legislation
2.3	Zoning regulations take into account specific ecosystem considerations and enforcement
2.4	Cross-sectoral mechanisms effectively incorporate sustainable land use planning into DRR legislation
2.5	NAPAs and National Adaptation plans include DRR and sustainable environmental management actions
2.6	National Biodiversity Strategies and Action Plans include DRR considerations.

2.7 National resources-related policies and environmental legislation (forestry plans, integrated coastal zoning management plans etc) include and implement risk assessments
2.8 National Sustainable Development Strategies include and implement risk assessments
2.9 Public and private infrastructure investments that include enforceable EIAs and risk assessments
2.10 Financial incentives in the form of tax rebates, subsidies, and other monetary and non-monetary rewards are for investments in ecosystem restoration and sustainable environmental management that emphasize ecosystems as part of disaster risk planning.

3. Ecosystem-based management and DRR

Risk assessments are integrated into:

3.1 Integrated Water Resources Management programmes
3.2 Integrated Coastal Zone Management programmes
3.3 Protected Areas management
3.4 Community Conservation Areas – these include local communities in ownership of conservation projects
3.5 Community-managed Marine Protected areas
3.6 Forest management plans
3.7 Integrated Forest Fire Management
3.8 Forest landscape restoration areas
3.9 River basin organizations for improved river management through stakeholder involvement
3.10 Livestock management – establishment of grazing practices
3.11 Fisheries management – establishment of quotas and regulations
3.12 Water management – equitable pricing and distribution schemes

4. Knowledge, participation and education

4.1 Public information and community participation are part of risk assessments
4.2 Non-state actors are involved in dialogue and implementation of DRR at the national and local levels, including civic groups, environmental, humanitarian and development agencies
4.3 Disaster practitioners and environmental managers are trained in integrated risk assessment, which include ecosystem management
4.4 Primary school children are educated in disaster preparedness and environmental stewardship

5. Human Well-Being and human security: reducing exposure to disasters and vulnerability:

Many excellent human well-being and human security indicators have already been developed, including from the following sources:

U.N. Commission on Sustainable Development indicators;
Human Development Index;
Human Poverty Index;
Gender-related Development Index;
Governance Index (Kaufmann);
Prevalent Vulnerability Index (Inter-American Development Bank);

6. Ecosystem health indicators by ecosystem type:

6.1 General
6.1.1 Changes in native species richness
6.1.2 Abundance of selected key species
6.1.3 Change in threat status of species
6.1.4 Number and area of Protected areas
6.1.5 Invasive alien species
6.2 Agro-ecosystems/forests
6.2.1 Land use changes
6.2.2 Vegetation cover
6.2.3 Percent of land degradation
6.2.4 Arable and permanent cropland area
6.2.5 Reduced dependency on fertilizer and pesticide use
6.2.6 Proportion of land area covered by forest
6.2.7 Area under sustainable forest management
6.3 Wetlands/rivers
6.3.1 Percent of area maintained as wetlands
6.3.2 Riverbank vegetation maintained
6.3.3 Water quality and turbidity
6.4.4 River fragmentation
6.4 Water
6.4.1 Drinking water quality
6.4.2 Bathing water quality
6.4.3 Proportion of total water resources used
6.4.4 Water use intensity by economic activity
6.4.5 Wastewater treatment
6.5 Coastal/Marine
6.5.1 Area of healthy seagrass beds and marine algae
6.5.2 Proportion of marine area protected
6.5.3 Health of marine ecosystems, as measured by marine trophic index

6.5.4 Coverage of live coral reef ecosystems
6.5.5 Area of healthy mangroves as buffer zones as measured by area, density and width

7. Threats to ecosystems are monitored

7.1 Climate change impacts
7.2 Conversion of ecosystems for urbanization and agriculture
7.3 Fragmentation of habitats
7.4 Slash and burn agriculture
7.5 Over harvesting of forest products
7.6 Desertification
7.7 Industrial logging/ illegal logging
7.8 Over grazing/ cattle ranching
7.9 Invasive Alien Species
7.10 Soil erosion
7.11 Eutrophication: overuse of fertilizers

Sources:
U.N. Commission on Sustainable Development (2007)
Cardona, Inter-American Development Bank, (2005)
Millennium Ecosystem Assessment (2005)
Convention on Biological Diversity
Environmental Vulnerability Index (2004)

El Cangrecal river, Honduras

Conclusions and future perspectives

Increasing numbers of extreme events causing casualties and affecting populations are weather and climate-related. However, climate change, although often cited as the culprit of rising numbers of disasters, is one of several factors increasing disaster vulnerability and environmental degradation.

The risk of suffering from any particular disaster depends on the size and frequency of the hazard event but even more on the vulnerability of people, often linked to environmental degradation and governance issues. Disasters are not caused by extreme events themselves, but occur when a society's capacity to cope with an extreme event is overwhelmed or mismanaged. For these reasons, the terms "natural disaster" and "natural hazard" have increasingly become misnomers (Hewitt, 1997; Wisner et al., 2004; Abramovitz et al., 2002).

Unfortunately, available economic statistics on disasters do not reflect lost agricultural land and livelihoods in developing countries. The more common and chronic disasters - shallow landslides, recurring flooding, rising seawaters, drought, and impacts of invasive species - impose the greatest costs on poor populations, and yet are not mirrored in official statistics on disasters. These small, cumulative disasters are most often those grounded in land use and pressure on natural resources, and are therefore often the most avoidable through appropriate ecosystem management.

Even if the number and frequency of extreme events increases, the magnitude of disasters can be reduced through adopting integrated approaches that combine development processes, disaster risk reduction measures, and ecosystem management. Combining ecosystem restoration in degraded areas with long-term views of settlement design and planning includes investing in ecosystems as cost-effective, successful alternatives and complements to physical engineering structures. We consider this guidance note to be one contribution of practical ideas and indicators for how to shape an integrated approach to disaster risk reduction. The "Environmental Guidance Note for Disaster Risk Reduction" is work in progress that will evolve with new experiences, success stories, lessons learned and good practices. However we are convinced that rather than controlling nature, which has all too often been the approach in the past, we have learned that we must work with nature if we are to keep ourselves safe while facing increasingly hazardous times.

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Annex 1

International environmental frameworks, conventions and agreements relevant to DRR Risk Management Indicators

UNESCO World Heritage Convention (Paris, 1972)

Convention Concerning the Protection of the World Cultural and Natural Heritage Established **by parties to protect cultural heritage and natural heritage, from damage and destruction**, including those caused by disasters.

Agenda 21 (1992)

Adopted by 168 countries in 1992, establishes sustainable development as a main policy goal. Especially relevant to disaster risk reduction is Chapter 7: Promoting Sustainable Human Settlement Development, which refers to developing a "**culture of safety**" in all **countries, especially those that are disaster-prone** (paragraph 7.60).

Convention on Biological Diversity (1992) (COP 6, the Hague, the Netherlands, 2002)

The Convention on Biological Diversity (CBD) has been ratified by 190 Parties. In decision VI/26 (2002), the COP adopted the Strategic Plan for the CBD. This so-called 2010 Biodiversity Target was subsequently endorsed by the World Summit on Sustainable Development and the United Nations General Assembly at the 2005 World Summit. The Summit also highlighted the essential role of biodiversity in meeting the Millennium Development Goals (MDG), and the 2010 Biodiversity Target has been incorporated into the MDGs. Of relevance here is the focal area within the 2010 target of: **maintaining ecosystem integrity, and the provision of goods and services provided by biodiversity in ecosystems, in support of human well-being.**

Convention to Combat Desertification (1994)

Relating specifically to drought, Part II of the Convention (on General provisions), paragraph 2, states that: In pursuing the objective of this Convention, the Parties shall: (d) promote cooperation among affected country Parties in the fields of **environmental protection and the conservation of land and water resources**, as they relate to desertification and drought.

UNFCCC (1994) and Kyoto Protocol (1997)

The Convention notes that Parties should take what ever actions are necessary, i.e. funding, insurance and the transfer of technology, to meet the specific needs and concerns of developing countries who will have to cope with the adverse effects of climate change **especially countries with areas prone to natural disasters** (article 4: Commitments, paragraph 8).

Hyogo Framework for Action (2005)

Since its adoption the "Hyogo Framework for Action 2005-2015: Building the resilience of Nations and Communities to Disasters", has led to many countries revising their policies to put disaster risk reduction at the top of their political and development agendas. The Hyogo Framework includes in section B (Priorities for action), section (4) on reducing underlying risk factors, which states: (i) Environmental and natural resource management (b) Implement integrated environmental and natural resource management approaches that incorporate disaster risk reduction, including structural and non-structural measures, such as integrated flood management and **appropriate management of fragile ecosystems**.

Ramsar convention (COP 9, Kampala, Uganda, 2005)

The Convention on Wetlands, signed in Ramsar, Iran, in 1971, is an intergovernmental treaty, which provides the framework for national action and international cooperation for the conservation and wise use of wetlands and their resources.

Resolution IX.9: The role of the Ramsar Convention in the prevention and mitigation of impacts associated with natural phenomena, including those induced or exacerbated by human activities Para 14: "ENCOURAGES Contracting Parties and River Basin Authorities to ensure that **wetland ecosystems are managed and restored, as part of contingency planning, in order to mitigate the impacts of natural phenomena such as floods, provide resilience against drought in arid and semi-arid areas**, and contribute to wider strategies aimed at mitigating climate change and desertification and thus reduce the incidence or magnitude of natural phenomena induced or enhanced by such change.

Annex 2

Selected tools and resources related to environment and DRR

Asian Disaster Preparedness Center *(www.adpc.net/v2007)*
- Community based DRM tool

CARE International *(www.care-international.org)*
- Community Vulnerability Capacity Assessment Tool

Center for International Climate and Environment Change – Oslo *(www.cicero.uio.no)*

Disasters and Environment Working Group for Asia *(www.dewga.net)*

Global Fire Management Center *(www.fire.uni-freiburg.de)*

International Institute for Rural Reconstruction *(www.iirr.org)*
- Ecosystem-based Disaster Risk Reduction
  International Institute for Sustainable Development/ Intercooperation/IUCN/SEI
- CRiSTAL (Community Risk identification Screening Tool for Adaptation and Livelihoods - *www.cristaltool.org*)

International Federation of Red Cross and Red Crescent Societies
(www.ifrc.org/what/disasters/resources/publications.asp)
- Vulnerability and Capacity Analysis

International Union for Conservation of Nature
- Tsunami guidelines *(www.iucn.org/resources/tools)*
- Integrating Environmental Safeguards into Disaster Management, Vol. 1 and Vol. 2 and Training module

(http://cmsdata.iucn.org/downloads/integrating_environmental_safeguards_into_disaster__management__vol_1.pdf)
(http://cmsdata.iucn.org/downloads/integrating_environmental__safeguards__into_disaster_management_vol_2.pdf)
(http://cmsdata.iucn.org/downloads/integrating_environmental_safeguards_into_disaster_management_vol_3.pdf)

- Ecosystems, Disasters and Livelihoods: An Integrated Approach to Disaster Risk Reduction*(www.iucn.org/about/union/commissions/cem/cem_resources/?340/Ecosystems-Livelihoods-and-Disasters)*
- Strengthening Decision-Making Tools for Disaster Risk Reduction, a case study from Northern Pakistan
  (www.iucn.org/about/union/commissions/cem/cem_resources/?1663/Disaster-Risk-Livelihoods-and-Natural-Barriers-Strengthening-Decision-Making-Tools-for-Disaster-Risk-Reduction)

Island issues *(www.islandvulnerability.org)*

La Red *(www.desenredando.org)*

Pro Act Network *(proactnetwork.org)*

Provention Consortium *(www.proventionconsortium.org)*

Risk RED *(www.riskred.org)*

Stockholm Environment Institute *(www.sei.se)*

United Nations Environment Programme *(www.unep.org/conflictsanddisasters)*

United Nations University-Environment and Human Security *(www.ehs.unu.edu)*

United Nations International Strategy for Disaster Reduction *(www.preventionweb.org)*

World Wildlife Fund
(www.panda.org/what_we_do/how_we_work/conservation/forests/news/?uNewsID=133901)
- Natural Security, Protected Areas and Hazard Mitigation, 2008

Indicators and indices

Characteristics of disaster resilient communities
(www.proventionconsortium.org/?pageid=90)

Convention on Biological Diversity (www.cbd.int)

Environmental Vulnerability Index, UNEP/SOPAC
(www.vulnerabilityindex.net/Files/EVI%20Descriptions%202005.pdf)

European Union Habitats Directive
(http://ec.europa.eu/environment/nature/legislation/habitatsdirective/index_en.htm)

Inter-American Development Bank
(http://idbdocs.iadb.org/wsdocs/getdocument.aspx?docnum=1481595)

Millennium Ecosystem Assessment *(www.millenniumassessment.org)*
OECD Key Environmental Indicators
(www.oecd.org/dataoecd/32/20/31558547.pdf)

U.N Commission on Sustainable Development
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Open-air school, post-earthquake Pakistan

Women bringing cabbages to market, Nepal

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