Opportunities in Environmental Management for Disaster Risk Reduction: Recent Progress

A Practice Area Review:
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on Disaster Risk Reduction

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1. Introduction

Managing forests to stabilize slopes in order to protect communities against landslides; introducing environmental technologies that combine hard engineering solutions with afforestation for coastal protection; and restoring wetlands to maximize flood regulation while safeguarding biodiversity and livelihoods in a changing climate—these are only a few examples of how environmental management reduces disaster risk around the world. While environmental management should not be viewed as a stand-alone panacea for addressing disaster risks, it has proven integral to achieving progress in disaster risk reduction.

Environmental management for disaster risk reduction does not exist as a formal field of practice. Instead, its scope is largely defined by the goals set by organizations working on related issues, namely: ecosystems conservation, sustainable development, disaster risk reduction and climate change adaptation / mitigation. Goals are pursued based on a common view that healthy ecosystems can reduce the impacts of natural hazards, while contributing directly to poverty alleviation, sustainable development and the achievement of the Millennium Development Goals.

At the global level, there is growing consensus around linking disaster risk reduction with environmental management. The Hyogo Framework for Action (HFA) calls for efforts to "encourage the sustainable use and management of ecosystems, including through better land-use planning and development activities to reduce risk and vulnerabilities." It promotes the implementation of "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."

In view of the HFA initiative, the UNISDR Global Joint Work programme for 2008-2009 seeks to ensure that "national and local authorities are better equipped to protect environmental services in coastal areas, flood and fire-sensitive basins and mountain ecosystems." The UNISDR Platform and Partnership for Environment and Disaster Risk Reduction (PEDRR) was established to promote an integrated approach to disaster risk reduction and ecosystems management that would support the implementation of the HFA.

While many conceptual frameworks have emphasized the need for incorporating both disaster risk reduction and ecosystem service maintenance in development planning, analyses that focus specifically on the *interaction* between disaster risk and environmental change are only beginning to emerge. The UNISDR Working Group on Environment and Disaster Risk Reduction, for instance, is developing an analytical framework that explores the interlinkages between environmental change and disaster risk based on five inter-related assertions:

(i) Natural hazards are physical processes that can be directly affected by social processes.
(ii) Healthy ecosystems often provide natural defences.
(iii) Degraded ecosystems reduce community resilience.
(iv) Although the environment itself is often well-adapted to natural hazards (with timescales for recovery varying significantly), disasters can lead to secondary environmental impacts.
(v) Environmental degradation is a hazard in itself.

Through recent, concrete examples, the purpose of this paper is to make an initial introduction of gateways for disaster risk reduction into environmental management and to review trends in the application of environmental management tools and approaches for reducing disaster risk. In this regard, environmental managers *are* disaster risk managers — or at least they could be. Instead of focusing on traditional fields of disasters risk management, this paper is organized around seven

areas of practice that environmental managers commonly undertake. Presenting the material in this way enables environmental managers to readily appreciate the relevance of their work in disaster risk reduction. Disaster managers are likewise better able to identify entry points for engaging with environmental managers.

2. The field of environmental management

The concept of sustainable environmental management is not new. Over 30 years ago in Stockholm, world leaders agreed on the urgency of responding to the problem of environmental deterioration. In 1992, at the United Nations Conference on Environment and Development in Rio de Janeiro, world leaders endorsed 'Agenda 21', a global programme that underscored the importance of environmental protection in sustainable development. In 2002 at the Johannesburg Summit, world leaders recognized poverty eradication, changing consumption and production patterns, as well as managing the natural resource base for economic and social development, as essential requirements for sustainable development.

Environmental management is now a well-established field but with diverse applications. In practice, there are many kinds of environmental managers engaged in different types of work. Environmental management may be viewed in general as a series of decisions taken by individuals and institutions to establish environmental conditions whereby multiple goals are pursued. Other environmental managers play supporting roles through capacity-building.

Ecosystems management is an important subset of environmental management. Taking an ecosystems approach to environmental management represents significant progress in this field. An ecosystems approach recognizes that natural processes go beyond administrative boundaries and will entail transboundary management of shared ecosystems. While multiple definitions of ecosystem management exist, its practice encompasses two common objectives: (i) management should maintain or improve ecosystems, and (ii) ecosystems should provide a range of goods and services to current and future generations.[1]

Disaster risk reduction is included among these ecosystem services, although it may not always be adequately valued. Decision-makers often pursue 'safe exploitation' of resources to meet current demands, utilizing ecosystem services and resources for economic gain or sustenance to the maximum limit without losing those services or resources entirely. However, the parameters of safe exploitation become further restricted when the role of ecosystems in mitigating disaster impacts is taken into account. It is therefore crucial to apply appropriate limits to sustainable resource use by means of effective environmental management.

Different types of institutions have been established around the world to oversee environmental management and minimize the environmental impacts of socio-economic activities. These include formal institutions such as national environmental ministries, sectoral agencies or sub-units responsible for environmental aspects of their work. Environmental institutions also comprise civil-based organizations such as NGOs and university extension services, as well as the private sector. Other environmental institutions are less formal, such as indigenous, community-based resource management systems. For example, in Eastern Indonesia, a ritualized set of taboos prohibits extraction of certain resources as supplies dwindle.

While some of these institutions are aimed primarily at environmental conservation, most view their work in a broader context and seek "sustainable uses of ecosystem services" which complements other socio-economic or political agendas. Acceptable levels of use are determined, formally or informally, through continuous negotiations based on multiple objectives (e.g. political, economic,

[1] Silviculture Laboratory (2006)

security and health-related interests). Decision makers who have access to information regarding accurate limitations of resource use or 'exploitation'—including future-adjusted price-tags of lost environmental services—are more likely to be effective environmental managers for disaster risk reduction.

The fields of environmental management and disaster risk reduction have three areas of work in common: (i) policy making, planning and operational decision-making; (ii) providing guidance for improved decision-making; and (iii) capacity-building for environmental management.

2.1 Policymaking, planning and operational decision-making

Decisions taken on behalf of institutions, whether by government bodies, NGOs or private companies, generally fall within three categories related to policy/legislation, planning and operations. Ideally, decisions at all three levels should be in accordance with each other. Policies stipulating limits, for instance, to wetland conversion are supported by planning decisions that prohibit new construction in protected wetlands, and also by operational decisions to enforce plans and implement wetlands restoration.

2.2. Providing guidance to decision makers

Environmental decision-making relies on relevant information in order to identify optimal and sustainable use of natural resources. Data may reflect the price tags of externalities and suggest recommendations for minimizing costs, or it can also demonstrate regional and local forecasting for successful agricultural production.

Providing appropriate information to decision makers is pivotal to ensure good environmental management practice and by extension, reduce disaster risks. Key stakeholders with access to information include, amongst others, scientists, analysts and economists. Other important actors who aim to influence and guide decision makers are lobbyists, advocates, the media, as well as the public-at-large. Finally, innovators also inform decision makers by demonstrating new technologies or approaches (such as lucrative green business ideas or technologies). The credibility of the informants' knowledge, determined partly by the relevance and reach of their knowledge base, is critical for influencing decision makers. New knowledge may also be generated through interaction with local or indigenous knowledge.

2.3 Capacity-building for environmental management

International development agencies and organizations, including the United Nations system, bi-lateral assistance programmes, NGOs, and multi-lateral financial institutions also play an important role in building capacities for environmental management in partner organizations at the national, sub-national and community levels.

3. Environmental management for disaster risk reduction: Seven areas of practice

This section describes seven entry points for engaging with environmental managers to support disaster risk reduction. A range of indicators may be used to measure progress towards an integrated environmental management and disaster risk reduction approach. Impact indicators could measure, for instance, increased area coverage under sound environmental management or protection and the corresponding reduction in disaster risk profiles of communities and their livelihoods. However, process indicators may also be applied to track progress in this field. The review identifies a number of process indicators for each of the seven entry points. This approach may be applied to assess

progress at national, regional or global levels focusing on types of ecosystems, for example by examining the integration of disaster risk concerns in wetlands management policies.

3.1. Environmental governance

Environmental governance offers important opportunities for mainstreaming disaster risk reduction into environmental management and for strengthening the environmental components of disaster risk reduction. Environmental governance includes policies, legal and regulatory frameworks and institutional structures to promote sustainable resource management. Policy or regulatory frameworks often specify levels of environmental protection and establish the means for monitoring and enforcing protection. Enforcement of policy, legal and regulatory instruments, however, remains a challenge.

National priorities

At national level, many countries have legislative and regulatory frameworks in place but are unable to enforce them, such as Sri Lanka, which had coastal management plans that predated the 2004 tsunami. Following the disastrous consequences of the tsunami, the Government of Sri Lanka recently produced a landmark roadmap for disaster risk reduction (see Box 1).

Box 1. Sri Lanka's roadmap towards improved environmental management and disaster risk reduction

Sri Lanka's roadmap for disaster risk reduction calls for a broad range of environmental initiatives and provides a costed plan that prioritizes these initiatives. These include, among others: disaster impact assessments as part of environmental impact assessment (EIA) measures, monitoring changes in hazard risks due to changing environmental conditions, monitoring nuclear radiation, preventing and improving response to oil spills, promoting soft engineering solutions for coastal protection (vegetation belts), better solid waste management, and advocating for environmentally sound technologies that minimize disaster risks.

There are other promising signs at country level of environmental managers becoming directly involved in disaster risk reduction work, indicating potential opportunities for improved integration. While there has been no formal review of the participation of environmental agencies in national disaster risk reduction platforms, it is notable that at least 16 national disaster risk reduction institutional focal points come from environmental ministries or the environmental divisions of other lead agencies. Similarly, while quantitative analysis of national environmental policies and legal instruments is not available, there is clear evidence of growing national attention to disaster risk reduction reflected in environmental policy and legal frameworks (see Box 2).

Box 2. Select OECD countries identify disaster management as an environmental security priority

In 2006, the Institute for Environmental Security prepared an inventory of environment and security policies and practices (IESPP) to determine how governments in the Organization for Economic Cooperation and Development (OECD) and intergovernmental organizations addressed their stated environmental security priorities through policies, programmes and projects.
Many of the national environmental policies reviewed identified clear connections to disaster risk reduction.

In a recent international policy statement, the former Prime Minister of Canada elaborated on a new cluster of threats, including "emerging challenges that have been generated by the process of globalization and the impact that environmental degradation has had in prompting natural

disasters." Likewise, the Government of Sweden acknowledged that "environmental destruction and the scarcity of resources have become common reasons for armed conflicts, natural disasters and their increasingly serious effects."

Regional initiatives

Regional intergovernmental organizations and fora have also articulated strong support for sustainable resource management and disaster risk reduction. The Department of Sustainable Development of the Organization of American States (OAS), for instance, aims "to mobilize the requisite technical and financial resources to support the implementation of programs that will assist the region in vulnerability reduction and resilience building….focused on development planning, parks and protected areas management, disaster risk management and climate change adaptation."

African environmental ministers are also at the forefront of efforts to reduce disaster risk regionally. At the 10th session of the African Ministerial Conference on the Environment (AMCEN) in June 2004, ministers adopted the Africa Regional Strategy for Disaster Risk Reduction. The Strategy was submitted to the AU Assembly Summit, where it was positively received by Heads of State and led to a call for developing a Programme of Action for its implementation.

Furthermore, during the 5th Ministerial Conference on Environment and Development in Asia and the Pacific in March 2005**,** participants noted the severe consequences of the 2004 tsunami and its subsequent earth tremors. They recognized the role of the natural environment to mitigate the impact of natural disasters. In the context of climate change and increasingly frequent disasters, conference participants endorsed the protection of natural barriers, as well as the establishment of national and regional integrated disaster preparedness and early warning systems, to reduce loss of life and adverse impacts on livelihoods.

Global agenda

Disaster risk reduction is also a growing priority that is reflected in the environmental policies of international financial institutions and leading environmental organizations. This is a significant development as their global reach enables them to potentially influence policies, programming, and projects at country and regional levels.

The Caribbean Development Bank (CDB), in particular, has integrated disaster risk reduction into their environmental impact assessments (EIAs), recognizing that there is a "disproportionate disaster impact" which strongly affects the work of development. EIAs, as an environmental regulatory instrument, represent important entry points for reducing disaster risks. EIA is a systematic process to identify, predict and evaluate the environmental effects of proposed actions or projects.[2] It also provides a mechanism for establishing acceptable thresholds of risk through public consultations and the use of technical experts and best-available science. In many countries, issuance of permits for projects remains subject to EIAs.

The CDB in cooperation with the Caribbean Community (CARICOM), an organization of 15 Caribbean countries, prepared a sourcebook for integrating natural hazard concerns, including potential climate change impacts, into EIAs that are practicable at country level. The CDB has field tested new EIA guidelines in their own projects, while Grenada and Trinidad and Tobago have already incorporated these proposed changes in their EIA processes. While this is significant progress, much work needs to be done before EIAs regularly address disaster risks. The most notable challenge in this regard is the lack of disaster risk information at the appropriate scale required.

[2] UNEP (2002)

Box 3 contains a description of current efforts by two other major international financial institutions – The World Bank and Inter-American Development Bank – to address disaster vulnerabilities through improved environmental management.

Box 3. Perspectives of two major multilateral institutions on minimizing disaster risks

The World Bank's Environment Strategy seeks to address global environmental challenges. One of its three main pillars is reducing vulnerability to natural hazards by "helping to prevent and mitigate the impacts of natural disasters; supporting upland resource management and payments for environmental services; improving weather forecasting and the dissemination of weather-related information; and managing land and coastal zone resources."

Similarly, the Inter-American Development Bank has advanced a disaster risk management policy in which "the bank acknowledges that development processes, such as rapid urbanization and environmental degradation may influence vulnerability to natural hazards and that vulnerability is often gender and poverty specific."

The United Nations Environment Programme (UNEP) is the UN's designated entity for addressing environmental issues at the global and regional level. Its mandate is to coordinate the development of environmental policy consensus by keeping the global environment under review and bringing emerging issues to the attention of governments and the international community for action. UNEP's Medium-Term Strategy 2010-2013, which has been endorsed by its Governing Council comprised of environmental ministers, identifies conflicts and disasters as one if its six priorities. In this regard, UNEP aims to build national capacities to minimize threats to human well-being from the environmental causes and consequences of disasters. The cross-cutting issues of disaster preparedness and development are being prioritized throughout the UN. In fact, as of 2007, a formal policy has been adopted to mainstream disaster risk reduction and the Hyogo Framework for Action through all areas of UN programming.

Taking into account the recommendations of international organizations on a voluntary basis, or binding commitments under international law (or conventions), many nations are seeing the necessity to work together on transboundary environment and resource management issues for the purposes of building resilience and for climate change adaptation. The UNISDR Global Wildland Fire Network is an example of a global exchange mechanism to enhance local to global governance in the prevention and management of fire (Box 4).

Box 4. Improving governance in fire management around the world

The UNISDR Global Wildland Fire Network, coordinated by the Global Fire Monitoring Center (GFMC), is operating through 13 Regional Wildland Fire Networks. Countries with advanced fire management systems are increasingly sharing information and methodological approaches with countries in the developing world or in transition. Emphasis is on capacity building of land owners or land users, as well as national agencies involved in the sustainable use and protection of forests and other vegetation resources for better fire management.

Furthermore, the Global Wildland Fire Network promotes transboundary cooperation in fire management between neighbouring countries or countries that wish to develop bilateral or multilateral cooperation in fire management, especially in providing mutual assistance during fire emergency situations. In the Mediterranean region, for example, activities include exchanging information among participating countries on their national fire risk reduction plans, training, establishment of a data base on forest fires, documentation about

preventive silviculture, as well as a study on socio-economic conditions of forest fire risk. Workshops have been held on multilateral assistance against forest fires in the Mediterranean Basin since 2003.

The most important development in international environmental governance is the emergence of new agreements on long-term cooperative action following the Kyoto Protocol to the UN Framework Convention on Climate Change (UNFCCC). Parties to the UNFCCC have identified the need for a complementary approach that clearly recognizes the linkages between higher global temperatures and increasing natural hazard intensity and frequency. They are calling for both reduced greenhouse gas emissions, as well as enhanced capacity for adaptation to extreme climate events through disaster risk reduction measures. Country-level efforts to advance environmental policies and legal instruments that deal with greenhouse gas reduction (which can include forest protection and afforestation) are essential to minimize future disaster risks and reduce potential losses due to environmental change.

3.2. Integrated planning

Integrated planning takes into account environmental considerations in land use decisions in rural / agricultural areas (e.g. crop planning, irrigation and resettlement) as well as in urban areas (e.g. water and sanitation and zoning for new development). While there are many varied examples of integrated planning, such as integrated coastal zone management and integrated water resource management, common elements include being spatially explicit (map-based), adopting multi-sectoral approaches and evaluating costs and benefits of potential land use. The best forms of integrated planning engage a broad range of stakeholders, including the affected communities and technical experts.

Integrated planning is especially important for disaster risk reduction, because it provides a framework for identifying high risk areas and vulnerable populations. By applying an integrated approach, planners can consider how changing land use, levels of agricultural production and loss of vital ecosystems, for instance, will affect community resilience against potential disasters. Integrated planning can therefore serve as a basis for determining risk reduction interventions.

Box 5. Land use planning as an effective tool for flood risk mitigation

In Ontario, Canada, improved land management, dating back to the 1940s and the soil conservation movement to protect agricultural watersheds, has significantly reduced socio-economic losses due to severe flooding events. Ontario's experience is in stark contrast to an area in Michigan affected by similar flooding events. Due to poor land management, this flood-prone area in Michigan has suffered major consequences, including loss of life.

In Australia, the Victorian Civil and Administrative Tribunal prohibited infrastructure development in Wellington Shire due to climate change projections of rising sea levels. Likewise, the Government of France has established zoning laws that specifically applies environmental management for disaster risk reduction. Noting "forest fires in the Luberon, floods in the Rhône Valley and droughts in the Languedoc", France's *Plan de Prévention de Risqués* designates certain zones free from construction while allowing it in other areas under certain restrictions.

Experiences from developed countries in North America, Europe and the Pacific illustrate how integrated land use planning can successfully address flood risks (Box 4). As demonstrated by the

experience in Ontario, progress in this practice area can be slow, but could eventually have a cumulative impact on reducing disaster vulnerability.[3]

Post-disaster recovery also has a critical need for integrated planning. If ill-planned, recovery can "recreate vulnerabilities, generate new risks and undermine sustainability and security."[4] In post-disaster contexts, integrated planning can help address local vulnerabilities that perpetuate disaster risks. For example, a number of post-tsunami projects approach recovery by combining livelihood, environmental management and disaster risk reduction concerns. During the recovery and reconstruction phases, projects can include providing settlements and services with environmentally-sound transitional shelter in areas with less exposure to hazards—and without creating new hazards by depleting water resources or over-exploitation of local timber or other resources. These temporary settlements can lead to permanently improved environment-livelihood situations, through building back better and not just rebuilding the same (or worse) vulnerabilities.

While the technical knowledge to support integrated planning in post-disaster recovery is available, political and community-level commitment need to be increased. There is often a disconnect between meeting the immediate needs of a post-disaster situation and long-term recovery and reconstruction planning. Efforts to integrate environmental issues through the early recovery work of the Inter-Agency Standing Committee, nonetheless, have generated important momentum. Steps are also underway to address a broader range of disaster risks through new initiatives and partnerships. The theme of this year's International Recovery Platform's Forum was "Building back greener and better." WWF has also partnered with the American Red Cross for the Green Recovery partnership, which focuses on protecting or enhancing the environment-livelihood situation during recovery, preventing the potentially negative impacts of recovery operations on the environment, and preparing local communities for disaster events.

Quantitative measures of the impacts of planning processes on the risk profiles of local communities are lacking. However, based on the numerous experiences cited and other emerging initiatives, it is evident that integrated planning actors can serve as receptive allies in reducing disaster risks. Increased effort is needed to engage with this community, introduce new knowledge and share successful practices. For instance, ecosystem valuation, which determines the risk reduction values of ecosystems, offers an opportunity to assess the costs and benefits of possible disaster risk reduction measures and thereby better guide environmental and development planners in their decisions.

3.3 Environmental monitoring and assessment

Environmental monitoring and assessment play an important role in generating relevant information that assists environmental and disaster managers in identifying risks, vulnerabilities and opportunities to promote community resilience.

Environmental monitoring and information

Monitoring and observing environmental factors that signal the onset of a hazard are fundamental to early warning systems. Such systems generally include a mix of space-based or remotely-sensed observations, as well as on-site, ground-based monitoring. For example, the Ministry of Environment in Japan demonstrated how forest-cover changes and soil erosion contributed to the increased magnitude of the 1989 Yangtze River floods by using satellite information through the APEIS-IEM Monitoring System and conducting computer simulations.

[3] Brown, Douglas, Syed M.A. Moin, Michelle L. Nicholson (1997).
[4] ISDR (2007).

Environmental monitoring systems also track trends in environmental degradation, such as deforestation, that underlie a local area's exposure to risk. Drought early warning systems perhaps represent the most important measure for monitoring exposure. One such system is the Drought Monitoring Centre in Nairobi, which regularly tracks environmental features (including rainfall) to assess the onset and severity of drought.

Environmental monitoring in conflict-prone areas has also led to progress in disaster risk reduction. In the three states of Darfur, Sudan, borehole groundwater monitoring has been incorporated as part of a drought resilience programme, benefiting 23 camps and 800,000 people (approximately 40 percent of internally displaced people in the area). In places like Darfur, where populations are mobile and resources already limited, monitoring becomes integral to sustainable resource management and the reduction of future risks.

Mapping hazard risk and exposure is another function of environmental monitoring. Mapping is commonly undertaken by national environment authorities. Most environmental management agencies carry the responsibility of providing at least some hazard mapping services, as these government bodies usually hold the core physical data sets and have well-established mapping capacities.

In addition to identifying hazard risk (flood, landslide, seismic activity, etc.), some environmental authorities also map environmentally sensitive areas. In Kenya, for instance, the KENSEA atlas provides information about the spread and distribution of natural resources along the coast to support the command centre responsible for operational and political decisions in the event of oil spills. Detailed Coastal Sensitivity Mapping (CSM) has also been carried out of sections of the East African Coastline to provide ready information during oil spill incidents to protect coastal areas. The same methodology is applicable in other coastal areas and readily adaptable in mapping other potential hazards (see Box 6).

Box 6. Coastal Sensitivity Mapping

Detailed Coastal Sensitivity Mapping (CSM) involves the development of a risk index and production of an Index Line on maps that depict sensitivity levels of critical physical and biological features (i.e. coastal resources) as well as human-related parameters (e.g. hotels, harbours, fish landing sites). The project will also produce Environmental Sensitivity Maps (scale: 1:50,000), develop and install an Environmental Sensitivity GIS Database at national level and train national staff in the maintenance and updating of the database. The database will contain the Environmental Sensitivity ArcGIS Geodatabase as well as all images related to the field work including geo-referenced topographical maps at 1:50,000, 1:100,000, and 1:250,000, and Landsat 7 etm scenes (7 bands) covering the entire Indian Ocean coastal area.

Environmental assessments

Environmental assessments produce targeted environmental analyses by reporting on current and anticipated future environmental conditions and identifying drivers of environmental change. Environmental assessments can utilize a broad range of methodologies, as there are many types of environmental assessments. These include post-disaster assessments that identify environmental damages and needs, as well as strategic environmental assessments (SEAs) that determine potential environmental consequences of development plans and policies. Information generated by environmental assessments are routinely included in early warning systems for all hazards. Initiatives, such as those by the OAS and UNEP, undertake site specific assessments to inform resource management decisions (Box 7).

Box 7. Improving local assessments of freshwater basins

The OAS Department of Sustainable Development is carrying out "basin-specific assessments" together with UNEP/Global Environmental Facility (GEF) in its efforts to improve local assessments of freshwater basins. In 2007, the GEF approved USD 11 million to be implemented by UNEP and executed jointly by five countries of the wider La Plata basin and the OAS/DSD to support the sustainable management of the La Plata basin. In the same year, the GEF gave a similar allocation to a four-year international waters project involving eight countries of the wider Amazon basin. Both of these projects seek to prevent disasters in the long-term and improve monitoring of water resources, as one of the expected consequences of climate change is reduced water levels in local catchments.

The Millennium Ecosystem Assessment (MA) is a landmark report because of its comprehensive and global scope. Initiated in 2001, the MA contains scientific assessments of the world's ecosystems—their condition, trends, and utility for human well-being if used sustainably. Information is provided in five technical volumes and six synthesis reports. It is also a milestone in the field of disaster risk reduction, paying special attention to the full value of ecosystem services, including their role in mitigating disaster risks – particularly flood and fire hazards. The report presents options for ecosystem conservation, enhancement and restoration, recognizing their important function in disaster risk reduction and livelihood protection.

Follow-up activities from the MA include the recommendation to line up with other global agendas, for instance those affecting disaster risk reduction and climate change. One specific recommendation of the Advisory Group for MA Follow Up states that "any follow up exercise on biodiversity and ecosystem services should as much as possible interact with other key processes including the IPCC for climate change and the Potsdam initiative on the macroeconomics of biodiversity."[5] The MA has already made international headway, currently considered by many as the "foundation" for linking biodiversity, changes in ecosystems and livelihoods, and can be an excellent tool for disaster risk management around the world, especially when follow-up activities collaborate with the climate change and disaster risk reduction communities.

Using environmental data to inform decision-making

Ongoing collection and use of environmental data is an indicator of progress for disaster risk reduction. The examples given in this section illustrate how interactions between environmental and disaster risk factors are being monitored and assessed and the analyses used to inform a variety of risk reduction activities. However, more work remains to develop guidance on integrated assessment methodologies and link these to specific risk reduction and environmental management decision-making processes. UNEP's Division of Early Warning and Assessment (DEWA) and Global Resource Information Database (GRID), for instance, are developing ways of better utilizing environmental data to influence decision-making on a regional and global scale (see Box 8).

Box 8. Managing global environmental data to analyze hazard risks and vulnerabilities

UNEP's DEWA and GRID provide technical expertise to prepare data and analyses for the Global Assessment Report and the Global Environment Outlook. These reports identify cross-sectoral global trends and include analyses of hazard risks. They are also beginning to incorporate analyses of vulnerability. UNEP further maintains the PREVIEW database, which provides access to a range of global level disaster risk and environmental datasets.

[5] Advisory Group for Millennium Ecosystem Assessment Follow-up

3.4 Environmental advocacy, education and communication

Environmental managers have long relied on a variety of approaches to encourage decision makers to support environmental initiatives. Advocacy is an important part of their day-to-day activities and may involve providing policy briefs or raising issues in public fora. In other instances, advocacy is more formalized, with professional lobbyists actively making the case for the environment.
The media plays an important role in this regard, as an advocacy tool through targeted communications campaigns, but also as a means for shaping and reporting on public opinion. Similarly, public opinion can be harnessed by environmental managers to influence policy and planning decisions, through ad hoc campaigns or formal public consultations (as in the case of strategic environmental assessments and environmental impact assessments). Finally, environmental education is another important tool for environmental advocacy with long-standing outreach programmes in communities around the world.

Like environmental managers, disaster risk reduction actors rely very much on both political and public commitment to bring their initiatives forward. In this regard, practitioners and advocates from both fields can support each other by re-enforcing the linkages between environmental and disaster risk reduction issues. An inter-linked environmental advocacy approach could help build a stronger case to influence political decisions and the wider public, as demonstrated by new partnerships emerging in Latin America (Box 9).

Box 9. Influencing political and public perceptions on the environment's role in disaster risk mitigation

Since the 1960s, the Organization of American States (OAS) has been advocating for governments to prioritize environmental concerns, and the impact of these efforts has recently become tangible. Political commitment to the environment and disaster risk reduction is strong, as shown by major funding allocations to national programmes that link water resource management to building future resilience against hazards (floods and fire outbreaks).

A successful advocacy campaign has led to better political prioritization, with many new projects involving a multi-government approach in the region. New initiatives address water resource management issues of shared basins, namely La Plata, the wider Amazon, the Artibonite and the San Juan. These are funded by major donors such as the Global Environment Fund, the World Bank, and the Caribbean Development Bank (see also Box 7). In addition, the Department of Sustainable Development/OAS is developing partnerships with the private sector for investment in environmental services; already 13 out of 34 member States of the OAS have payment for ecological services programmes, and this trend will likely increase.

New organizations and partnerships have surfaced in recent years with a focus on improving local and national understanding of disaster risk reduction through education and advocacy. These initiatives often address issues related to human-environment interactions and increasing community resilience. Special attention should be paid to educating policy makers and community groups about the special needs of women in responding to disasters and as agents for sustainable resources management. Women are much more likely to die during a flooding event due to their lack of swimming skills and constraining garments. They are also more likely to be stewards of natural resources, from tending livestock to forage cutting and managing water supplies. For example, Risk Reduction Education for Disasters offers several projects in this area, including the publication of workbooks, on-site trainings, workshops and reviews of development programming to improve resilience. Within UNEP's work in many African countries, UNEP has collaborated with the UNISDR to develop educational materials that highlighted the role of the environment in reducing disaster risk.

3.5 Protected areas, ecosystem rehabilitation and natural resource management

Environmental conditions not only modify the frequency of hazard events, but ecosystems also serve as natural barriers that can moderate the effects of a hazard and protect communities. "An ecosystem is a dynamic complex of plant, animal, and microorganism communities and the non-living environment interacting as a functional unit…" and ranges "from those relatively undisturbed, such as natural forests, to landscapes with mixed patterns of human use, to ecosystems intensively managed and modified by humans, such as agricultural land and urban areas."[6] Ecosystems are socio-ecological systems, and managing ecosystem services is highly relevant for the purposes of disaster risk reduction.

There has been a broad increase in community-based resource management, technical advances and multi-stakeholder processes. Because these efforts are so diverse and widespread, with practitioners often working outside the framework of national disaster reduction mechanisms, the potential applications of their efforts are not always known to the disaster management community. While they are obviously cross-cutting, examples of protected areas management, ecosystem restoration and natural resource management around the world illustrate how field-based decisions continuously balance livelihood priorities with environmental sustainability concerns. Pro-actively managing natural areas can ensure protection of the environment and reduce underlying risk factors for disaster by maintaining the resilience inherent in ecosystems.

Protected areas

Investments in protected areas can pay off in terms of hazard risk reduction. The economic benefits of ecosystem services are increasingly being quantified due to their impacts on hazard risk reduction. In Switzerland, for example, the benefits of protected forests are estimated between USD 2 to 3.5 billion per year, because of risk mitigation against avalanches, landslides, rockfall and flooding. The threat of new hazards has even prompted restoring previously degraded areas. In the eastern part of Madagascar, deforestation had exacerbated flooding from annual monsoon rains. However, with the gazettement of the Mantadia National Park in 1989, which included the Vohitra River watershed, the estimated 1997 value of watershed protection in terms of reduced crop damages was USD 126,700—a substantial amount by local standards.[7] Finally, the successful case of floodplain protection in the Czech Republic further demonstrates the value of protected areas in reducing hazard risks (Box 10).

Box 10. Utilizing natural defences by protecting floodplains in the Czech Republic

The River Lužnice floodplain is an interesting case of preserving and utilizing natural flood mitigation systems instead of relying on human-made or artificial measures (polders) to protect surrounding communities. The floodplain has escaped major human alterations and maintains a preserved hydrological regime. It is capable of retaining 10,251 m^3 ha^{-1} in volume in a real flood situation which comes essentially 'free of charge', if the resource is managed well. On the contrary, artificial systems represent a cost of USD 23 per one cubic meter of water retention during a flood. Using natural floodplains therefore represents substantial savings for the Czech Republic. Natural floodplains provide other benefits that engineered structural defences do not: biodiversity; production of hay, wood, and fish; and carbon sequestration. These combined benefits were estimated to have a value of USD 27,000 per hectare per year in the River Lužnice floodplain.[8]

[6] Millennium Ecosystem Assessment (2005)
[7] Czech Academy of Sciences in ProAct Network (2008).
[8] Ibid

Global climate change awareness has spurred a new drive to fund protected areas. The World Bank has put forward new Climate Investment Funds (CIFs) estimated between USD 7-12 billion. These funds include the Forest Investment Fund and the Adaptation Pilot Fund / Climate Resilience Pilot Program. The Forest Investment Fund will finance efforts to reduce deforestation and also collaborate with participating countries involved in the Forest Carbon Partnership Facility (FCPC).[9] Carbon sequestration from forests is also increasingly regarded as a long-term resilience-building investment. Canada, for instance, estimates 4.43 gigatons of carbon for sequestration in 39 national parks with a USD 72-78 billion value. Reforestation in Uganda is valued at USD 14.4 million per year as carbon sinks.[10]

Nonetheless, there is partial progress in many places. For example, a recent WWF Report states, "Although a number of protected areas have been established in the Gulf Coast Prairies and Marshes Ecoregion in the United States, they still represent only 14 percent of the total land area that is almost entirely comprised of ecologically sensitive marshes and wetlands."[11] The United Kingdom, on the other hand, has moved toward a balanced risk approach using the restoration of peat bogs, natural flood plains, and lowland marshes as a complement—though still not a replacement—to human-made anti-flood methods.

Protecting and preserving the natural position and trajectory of wetlands and other water resources has received increasing support, given the risks if those wetlands were eliminated, reduced or altered in major ways, i.e. for housing and infrastructure purposes. In many areas, it is no longer politically viable to clear away wetlands for human-made conversions. Due to this heightened awareness, wetlands, lakes and watersheds have received unprecedented funding for restoration and conservation around the world. For instance, the Wetlands Reserve Program (WRP) in the United States included nearly 750,000 ha, a significant move towards establishing anti-flood measures.[12]

In some protected areas, unintended consequences may result when disaster risk concerns are not considered at the outset. In one case concerning a park in Kenya, for instance, pastoralists excluded from a newly-established protected area were made more vulnerable to drought. Displacement restricted pastoralists' access to the only available water resource during the dry season inside the park. A subsequent drought led to increased stress on other water sources east of the park. In this case, poor environmental governance increased community vulnerability to drought and contributed to resource degradation, thus heightening local conflicts over limited water resources.

Ecosystem rehabilitation

Ecosystem rehabilitation or restoration entails a wide array of activities, including post-disaster clean-up, e.g. after an oil spill, as well as replanting of forests or mangroves. Restoring ecosystems following natural and human-made disasters can work to reduce the underlying risk factors and mitigate future disaster impacts. Decisions at the field level require detailed knowledge of local environmental conditions (e.g. planting regimes, species choices) and competing community needs.

Experiences in Japan show how restoring river systems can serve as an important anti-flood strategy (Box 11). In northern Pakistan, IUCN together with UNEP/GRID-Europe and other partners embarked on reforestation efforts to guard against landslides (Box 12).[13]

[9] Shamsuddoha (2008)
[10] WWF and Equilibrium (2008)
[11] Ibid
[12] Ibid
[13] IUCN Pakistan in ProAct Network (2008)

Box 11. River restoration as a flood mitigation measure in Japan

As early as 1936, river restoration and improvement projects in Japan have been utilized as a means to mitigate risk against recurrent flooding during typhoons or periods of excessive rainfall. Flooding often affected surrounding areas—including densely populated urban areas. Over time, based on lessons learned which linked local damages by previous floods to degraded environments around rivers, river restoration projects were increasingly implemented across the country. The Ministry of Construction recently scaled up its historical river improvement initiatives by introducing the Naturally Diverse River Improvements (NADRIM) programme. River improvements directly benefit flood mitigation and the natural river environment. National recognition of the multiple benefits of river restoration was formalized in 1997 under a clause in the River Law which states the "improvement and conservation of the river environment" as a primary objective in conjunction with flood control and general protection of water resources.[14]

Box 12. Stabilizing slopes through reforestation in Pakistan

In Pakistan, it was found that a great number of landslides in the area were due to poor environmental management—deforestation, grazing, poor terracing as well as inadequate housing development in proximity to exposed slopes and rivers. Proposed recommendations included reforestation and slope stabilization as a disaster risk reduction and a forest restoration measure. The Governments of Azad Jammu and Kashmir declared 2007 as the "Year of Plantation."

Natural resource management

Although the linkages between environmental management and natural hazards are increasingly recognized, the many cases of natural disasters due to poor resource management illustrate that further progress is needed. For example, many fire-sensitive ecosystems, such as tropical rain forest or peatlands, have been affected by land clearance, drainage, and excessive fire application and are now heavily degraded. By contrast, other ecosystems that previously remained in relatively stable equilibrium with natural fires or traditional land-use systems now face fuel accumulation and unprecedented risk of uncontrolled wildfires. This is the case in some parts of Europe where there have been rural exoduses.

Other cases around the world show how poor risk management initiatives using human-made structures and radical methods altered the environment so substantially that they in effect created new or worse risks. For instance, past efforts in the United States to mitigate flooding along the Mississippi River led to the creation of a massive network of artificial channels, which exacerbated flooding problems in 1973, 1982, and 1993.[15] Around 85 percent of the river basin's wetlands was lost, and changes in riparian and in-stream habitat were dramatic.[16] Attitudes are beginning to change, however, toward utilizing natural methods for flood prevention. Projects in the Mississippi are currently being implemented to replace "structural means for flood control with floodplain restoration and management."

Unfortunately, experience shows that it too often takes major losses from a disaster event to create momentum in making significant environmental improvements toward reducing risk. This is despite the fact that it is actually more cost effective to act before a major disaster event strikes. For instance, the 1993 Mississippi River flooding submerged 75 towns, killed 48 people, cost USD 10-

[14] Nakamura (2000)
[15] WWF and Equilibrium (2008)
[16] Ibid

20 billion and relocated vulnerable residents to reduce future losses.[17] While political and social barriers remain in both the developing and developed world, there is marked progress at least in integrating disaster risk reduction in natural resource management.

Integrated watershed management, which is now widespread, is a promising area. The most successful approach involves forest communities and includes provisions to sustain local livelihoods. Examples from China and Korea demonstrate effective approaches to engage communities in forest management as part of flood risk reduction. The RAMSAR Convention on Wetlands is another example of a global initiative that aims to balance social, economic and ecological priorities through the sustainable resource management of wetlands (Box 13). Managing water resources sustainably involve allocating water resources based on various demands, while maintaining environmental flows required to sustain ecosystem services, especially in the context of changing climate and hydrological conditions.

Box 13. Promoting disaster risk management in RAMSAR sites

In 2005 contracting parties to the RAMSAR Convention on Wetlands issued a new statement on the role of the RAMSAR Convention in natural disaster prevention, mitigation and climate change adaptation. All contracting parties are encouraged to ensure that wetland ecosystems are managed in a way that mitigates the impacts of natural disasters, for example by impeding flood waters and tidal surges and providing resilience in arid and semi arid zones against drought. In the US, the Coastal America initiative illustrates how government, private sector and other partners have joined together to support broad-ranging wetlands management efforts. In Australia, the Queensland Wetlands Programme provides case studies, technical publications, and monitoring data repositories available online to help tackle issues of wetland loss and degradation.

Community participation in forest and fire management has also played an important role in reducing risk of devastating wildfires. Fuel reduction employing both the use of mechanical means as well as controlled (prescribed) fire contributes to a reduction of wildfire hazards and the risk of high-severity wildfires. Involving local communities in effective forest fire management is essential; they can reduce incidences of unplanned ignitions and generate increased public commitment to reduce wildfires. The UNISDR Global Wildland Fire Network, for instance, is strongly promoting community-based fire management approaches as well as the application of ecologically sound burning techniques to achieve sustainable land management goals. One experience in Australia highlights the value of indigenous environmental management systems in reducing fire hazards (Box 14).

Box 14. Aboriginal communities as fire managers

Indigenous fire management in northern Australia is being implemented through a private-public-civil partnership that places aboriginal people in the leading role as fire managers.[18] Aboriginal communities are able to reduce the number of unmanaged fires, while also reducing green-house gas emissions (GHGs) from Arnhem Land creating a tradable carbon offset. Savannah fires account for the largest source of GHG emissions in the Northern Territory. In return, Darwin Liquefied Natural Gas plant (the private sector partner) grants approximately USD 1 million over the next 17 years to aboriginal communities for local development. One challenge is that many areas are no longer inhabited or managed by aboriginal people. Efforts are being made to motivate aboriginals to return to these lands and embark on similar partnerships.

Appropriate management of coastal forests can also protect local communities from coastal hazards. In Vietnam, the Red Cross worked closely with local communities to restore coastal forests as

[17] WWF and Equilibrium (2008)
[18] ProAct Network (2008)

protection against tropical storms. Similar efforts are underway in Southern Thailand. While there is conflicting evidence regarding the role of mangroves in protecting communities from the 2004 tsunami, it is generally accepted that mangroves can reduce community vulnerabilities to tsunamis of lesser magnitude, storm surge and coastal flooding. In September 2006, the World Conservation Union, with support from the office of the UN Special Envoy for tsunami recovery, Bill Clinton, launched Mangroves for the Future (MFF), an initiative that restores and protects mangrove forests throughout tsunami-affected areas, recognising their value in costal protection and other ecosystem services.

Developing countries that are highly reliant on agriculture must find ways to adapt to a variable and changing climate in order to maintain and improve people's livelihoods. One successful experience in this area is spearheaded by Jordan, where agricultural planning restricted grazing and was therefore able to restore sufficient vegetation cover and build resilience against recurrent droughts.[19]

These cases illustrate the potential role of natural resource management, ecosystem restoration and protected areas in risk reduction. However, the continued poor management of land and other resources perpetuates or even increases risks, highlighting the need for increased capacity-building and advocacy among national as well as local environmental and disaster managers operating in high risk areas. Protected areas, ecosystems restoration and natural resource management that do not incorporate disaster risk reduction objectives represent a missed opportunity. More effort is therefore required to engage this community to support disaster risk reduction.

3.6 Environmental innovation, technology and industry

Policy makers, planners and even the general public are often influenced by innovative alternative technologies, usually provided by the private sector. This includes green engineering solutions for sanitation, energy, water use /management, structural defenses from hazards and construction planning that is environmentally sound or includes bio-engineered elements. Bio-engineering solutions and eco-materials can be used instead of or in conjunction with hard engineering solutions. Eco-netting, for instance, has proven effective at erosion control and reducing landslide risk, whereas coastal afforestation complements the use of human-made sea-walls. In Darfur, turf roofs were used to deal better with temperature extremes inside dwellings and fuel-efficient stove projects aimed to limit localized deforestation and reduce hazards risks (flooding and droughts). The future will undoubtedly see a growing role for green industries that make environmentally-friendly alternatives available to the mass market. One general indicator of progress for disaster risk reduction is investment (foreign or domestic) into green development.

The private sector plays an important role in establishing markets through incentives that favor the environment. New instruments such as carbon markets present opportunities for disaster risk reduction, while at the same time increasing the recognized value of preserving forest ecosystems. Carbon markets offer funding through climate change mitigation projects that have dual benefits of climate change adaptation and disaster risk reduction. Similarly, emerging markets that promote payments for ecosystems services can be linked with risk transfer and insurance mechanisms. In this regard, the private sector establishes new means for both environmental protection and disaster vulnerability reduction, while providing more efficient and clean ways to use resources sustainably.

Another important indicator of progress in this area is reflected in new and innovative research and valuation analyses that integrate environmental management and disaster risk reduction concerns. For instance, quantifying the value of ecosystem services has stimulated investment by major banks, especially for guarding against future risks related to climate change. The insurance industry is actively pursuing new index-based insurance programmes tailored for agricultural communities to

[19] WWF and Equilibrium (2008)

transfer risk. Despite disagreements over whether these schemes provide sufficient incentive for changing risk-prone behaviours, there is active dialogue. Some players are beginning to consider how payments for ecosystem services might be included in risk transfer mechanisms.

Valuation analyses also assist in prescribing the appropriate balance for human-made innovations with natural, environmental methods for risk reduction. In many cases, it is economically more advantageous to utilize the natural environment, rather than forego ecosystem conservation or restoration by applying human-made interventions. Nonetheless, communities around the world are protected from floods and storms by engineered structural defenses. While the efficacy of these structures is at times called into question, particularly when they result in significant downstream impacts, they will no doubt continue to comprise a significant component of disaster prevention.

In recent years, however, there is greater emphasis towards adopting natural, environmentally-informed alternatives. The Government of Japan, for example, is moving away from constructing concrete river walls and shifting towards natural river restoration for flood protection. In Sri Lanka, the Disaster Management Center is studying the potential benefits of "soft engineering" approaches to coastal defense. In the US, communities in California rejected several proposed flood mitigation plans and opted for an innovative combination of bank terracing, parkland bypass channels and restoration of downstream tidal wetlands. Likewise, in the Maldives, structural measures to reclaim land from the sea are being re-evaluated, given their impact on the ability of island ecosystems to naturally adapt to rising sea levels.

These examples draw attention to a range of initiatives in which innovative environmental technologies have helped reduce risk and even supported the development of new markets or industries. While environmental innovations represent progress, much more can be accomplished to promote the economic viability of green technologies, wider research and the development of new technologies.

3.7 Building capacities in environmental management

Capacity-building in environmental management generally comprise three aspects: human resources, financial resources and institutional development. Capacities in designated environmental management institutions are usually developed through training or other forms of human resource development. Strengthening financial capabilities may be achieved through grants, seed money or capital investment, while building institutional capacities includes ensuring that institutional policies and structures are in place to deliver services. Institutions and organizations should also be capable of facilitating inter-sectoral coordination and dialogue between the users and producers of scientific information, enabling more fruitful connections between informers and decision makers.

Building capacity in environmental management supports disaster risk reduction by increasing awareness and maximizing opportunities for engaging in joint or integrated efforts. For instance, limited resources offer excellent opportunities to design linked capacity-building programmes, such as joint training between environmental and disaster risk reduction actors. When many projects are implemented separately without collaboration between environmental and disaster risk reduction practitioners, significant opportunities are lost. Initial indicators of progress might include the number of personnel or organizations trained and increased levels of development assistance marked for joint environmental and disaster risk reduction programmes. The learning curve about the role of ecosystems in disaster risk reduction remains dynamic and looks promising, especially at the level of local resource management (see Box 14).

Box 14. Building local capacities for rainwater harvesting

In 1998, Practical Action South Asia, an NGO, approached a drought-prone community in the village of Muthukandiya in southern Sri Lanka to provide technical assistance for rainwater harvesting. Previous attempts to introduce rainwater harvesting failed because water tanks were provided without training villagers on their use and maintenance.[20] Their new approach recognized the importance of advocacy and education in gaining government and public support and long-term commitment, with better results. Financial resource issues, however, constrain the spread and up-scaling of these successful efforts.

Building resilience against climate change-related hazards is of particular gravity for island communities, and many new capacity-building projects target the particular needs of these communities, including initiatives that also protect local heritage and culture at the same time. A major form of resilience is of course development, and carefully shaping development around certain natural heritage sites through external capacity-building initiatives for environmental management and research have proven successful[21]. Both conservation and natural heritage benefit from the new revenues created from tourism and research centers, their management taken over by indigenous populations. The Galapagos, Rathlin, Brownsea, Colonsay, Scotland, Great Barrier Island, New Zealand, and the Faroe Islands are examples using natural heritage management for environmental management, which means the local population can benefit economically while contributing to conservation. The economic benefits and the improved environmental management transfer to resilience against future adaptation needs stemming from climate change and increased natural hazard risk.

Finally, working through established networks and partnerships in the field of environmental management can be a useful means for integrating disaster risk reduction. Efforts are underway, for instance, to bring risk and vulnerability information into coastal zone management through the Mangroves for the Future initiative in the Indian Ocean Region, a multi-country, multi-agency, multi-stakeholder initiative aimed at improving coastal zone management and reducing flood risks. Disaster risk reduction training in coastal zone management, targeting planners and implementers in both national and local governments as well as NGOs, are already underway.

4. Concluding remarks

This review has presented many examples of how the field of environmental management supports disaster risk reduction. Some environmental management is already by design contributing to progress in risk reduction, for example by incorporating disaster risk reduction directly into EIAs. This is also the case when wetlands or forested areas are protected for the purpose of flood or landslide mitigation or when national governments and regional partners prioritize environmental management as a resilience measure through policies and programming.

Environmental managers can achieve highly beneficial results that reduce exposure to hazards, even if they are not explicitly integrating disaster risk reduction into their agendas. There work can benefit from integrating risk issues into environmental management. Likewise, the disaster risk reduction community should recognize the added value of engaging with environmental managers and practitioners to support its work. Progress in the various practice areas of environmental management can also translate into progress in disaster risk reduction. The fact that carbon markets are increasing the recognized value of forest ecosystems and the extent of protected areas is one example of success in environmental management, which also presents new opportunities for promoting disaster risk reduction.

[20] Practical Action (1998)
[21] Kelman, Ilan (2007)

Both environmental and disaster risk managers can achieve much more by strengthening and expanding their partnerships. Collaboration prospects are ample, and in some instances achievements in both disaster risk reduction and environmental management would remain limited without cooperation. For instance, closer linkages between the two areas could finally provide decision makers with the complete value or price tag of ecosystems by including both the long-term risk reduction values of healthy ecosystems, as well as the immediate values of goods and services to local populations or industries. Environmental managers working in the field generally have access to local data and to in-depth knowledge of local practices and environmental trends. This could be a valuable resource for the disaster risk reduction community.

Many of the concepts presented in this review are not new. For instance, the value of indigenous knowledge and capacities for environmental management, as well as the link between functioning ecosystems and reduced risk, are widely recognized. The question is why that information is not more widely applied and what should be done to strengthen and combine the agendas of environmental managers with disaster risk reduction. This paper presents numerous examples of progress and illuminates potential opportunities for collaboration, but barriers must still be overcome to spread the implementation of these lessons more widely.

Several overarching issues have been identified. Priorities should include filling in the data gaps (e.g. disaster risk assessments at country and community level), downscaling generalized knowledge for local-level applications, and scaling up good practices through outreach and capacity building. Greater cooperation and information flow in both directions is needed between developed and developing countries; strategies and potential for application differ in each location, and having the most comprehensive environment and risk data available in line with local practices and knowledge would optimize resource management and disaster risk reduction potential. In addition, because of the diverse range of actors involved, there is a disconnect between organizations, governments, and communities, who might be conducting similar projects in separate, isolated locations. In many instances, environmental managers, climate change actors and disaster risk managers duplicate projects.

One of the most easily surmountable barriers to project implementation is the limited extent of collaboration between practitioners in these allied fields. It is important to strengthen the involvement of environmental managers in national disaster reduction mechanisms. Current practice in environmental management has already been shown to reduce disaster risks; its potential contributions to disaster risk reduction could be further maximized with more deliberate cooperation and engagement. Failures to identify the mutual benefits of environmental management, risk reduction and climate change adaptation are lost opportunities to protect lives and promote human well-being.

Bibliography

Advisory Group for Millennium Ecosystem Assessment Follow-up

Brown, Douglas, Syed M.A. Moin, Michelle L. Nicholson (1997). "A Comparison of Flooding in Michigan and Ontario: 'Soft' Data to Support 'Soft' Water Management Approaches." *Canadian Water Resources Journal*, vol. 22, No. 2.

Czech Academy of Sciences in ProAct Network 2008. "The Role of Environmental Management and Eco-engineering in Disaster Risk Reduction and Climate Change Adaptation."

International Strategy for Disaster Reduction (ISDR) (2005). *Hyogo Framework for Action 2005-2015: Building Resilience of Nations and Communities to Disasters*. World Conference on Disaster Reduction, January 2005, Kobe, Hyogo, Japan.

ISDR and UNEP (2007). "Environment and Vulnerability: Emerging Perspectives."

Intergovernmental Panel for Climate Change (IPCC). *4th Assessment Report*: *Climate Change 2007*.

IPCC Working Group II (2007). *Impacts, Adaptation, and Vulnerability*, Contribution of IPCC WGII to the IPCC Fourth Assessment Report, Cambridge University Press: Cambridge.

Kelman, Ilan (2007). "Sustainable Livelihoods from Natural Heritage on Islands." *Island Studies Journal*, vol. 2, no. 1, pp 101-114.

Millennium Ecosystem Assessment (2005). *Ecosystems and Human Well-being: Current State and Trends: Findings of the Condition and Trends Working Group*, Island Press: Washington, D.C.

Miththapala. S (2008). *Incorporating environmental safeguards into disaster risk management*. Volume 1: Reference material. Colombo: Ecosystems and Livelihoods Group, Asia, IUCN. viii + 130 pp.

Miththapala S (2008). *Incorporating environmental safeguards into disaster risk management*. Volume 2: The Disaster Management Cycle. Colombo: Ecosystems and Livelihoods Group, Asia, IUCN. Vi +43 pp.

Nakamura, Keigo (2000). "Restoration of rivers and lakes in Japan." Water Environment Research Group of the Public Works Research Institute.

Practical Action (1998). "Rainwater Harvesting." http://practicalaction.org/?id=rainwater_case_study

ProAct Network 2008. "The Role of Environmental Management and Eco-engineering in Disaster Risk Reduction and Climate Change Adaptation."

Rietbergen-McCracken, Jennifer and Hussein Abaza, eds. (2000). *Environmental Valuation*. United Nations Environment Programme: Earthscan Publications, Ltd, London.

Schipper, Lisa and Mark Pelling (2006). "Disaster risk, climate change and international development: scope for, and challenges to, integration." Disasters 30 (I) Overseas Development Institute. Blackwell Publishing, Oxford: pp 18-38.

Shamsuddoha, M.D. (2008). "Australian CSO statement on the World Bank Climate Investment Funds." World Bank Annual Meetings, Washington DC, 11 - 13 October 2008.

Silviculture Laboratory (2006). University of Washington, College of Forest Resources http://silvae.cfr.washington.edu/

Sudmeier-Rieux, Karen, Hilary Masundire, Ali Rizvi, and Simon Rietbergen, eds. (2006). *Ecosystems, Livelihoods and Disasters: An Integrated Approach to Disaster Risk Management.* IUCN: Gland.

Sudmeier-Rieux, K., Qureshi, R.A., Peduzzi, P., Nessi, J., Breguet, A., Dubois, Jaboyedoff, M., Jaubert, R., Rietbergen, S., Klaus, R. and M.A. Cheema (2007). **"**Disaster Risk, Livelihoods and Natural Barriers, Strengthening Decision-Making Tools for Disaster Risk Reduction: a Case Study from Northern Pakistan." IUCN Pakistan, GIAN, UNEP, UNIL vi+50pp.

UNEP (2002). Environmental Impact Assessment Training Resource Manual.

UNEP World Conservation Monitoring Center (UNEP-WCMC) (2006). *In the front line: shoreline protection and other ecosystem services from mangroves and coral reefs.* UNEP-WCMC, Cambridge, UK.

World Wildlife Fund (WWF) and Equilibrium (2008). *Natural Security: Protected Areas and Hazard Mitigation.*