ECOSYSTEM APPROACH TO DISASTER RISK REDUCTION

Basic concepts and recommendations to governments, with a special focus on Europe

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European policy makers are already faced with difficult decisions about which investments are needed to face a changing climate but often opt for "hard engineering" options over "softer" investments, such as wetlands to provide natural reservoirs for excess water, coastal vegetation, protection forests, in addition to better preparedness, early warning systems and post-disaster recovery strategies. The European disaster risk reduction (DRR) and climate change adaptation (CCA) context present a number of specific challenges to policy makers, mainly related to concentrated populations near major rivers. The sheer scale of risks posed by climate change and variability, in conjunction with globally widespread ecosystems decline, requires solutions that are cost-effective but also locally accessible and applicable. Exposure, one of the major drivers of risk is difficult but not impossible to reduce in densely populated Europe. Physical structures, especially dykes, have been erected in most European cities and provide significant protection to urban areas. Oftentimes, hybrid solutions are possible, combining both engineered structures with so called "natural infrastructure", as long as the engineering structures do not interrupt natural processes.

Depending on the territorial context, both engineered and natural infrastructure have their advantages and disadvantages. Both have limitations to the amount of energy they can absorb from "physical hazards", i.e. flooding, wind storms and landslides (ISDR, 2011). Physical engineered structures are limited by their age, quality of materials and location relative to the physical hazard. Natural infrastructure is limited by its relative degradation, amount of space accorded to an ecosystem and the amount of energy released by a hazard event. For example, a wetland may be effective in absorbing excess flood waters but only if accorded enough space to hold the additional water. Physical barriers may have the disadvantage of acting as "false security" for populations who may over-rely on engineered structures for protection. Natural infrastructure, on the other hand, provide other multiple benefits in addition to protection, many that cannot be quantified, such as aesthetics, recreational opportunities, a sense of well-being or fresh air, especially in densely populated urban areas. The bottom line is that investing in natural infrastructure can be considered a "low-regrets" strategy with additional advantages to European populations besides their protective role. Yet, ecosystem-based strategies are often overlooked by decision makers as cost-effective and effective components of disaster risk and climate change policies and practices.

Fortunately, the policy context over the past five years has evolved to include ecosystem-based strategies for DRR and CCA, although more progress is still needed. The latest IPCC Special Report on Extreme Events (SREX) report lists investing in ecosystems as "low-regrets" measures alongside early warning systems; risk communication between decision makers and local citizens; sustainable land management, including land use planning; and ecosystem management and restoration (IPCC, 2012). The 2011 and 2009 Global Assessment Reports (UNISDR, 2009; UNISDR, 2011) listed environmental degradation as one of the main drivers of risk. During the course of UNFCCC negotiations for a global climate agreement and in particular since the Conference of Parties (COP) in Copenhagen in 2009, ecosystem-based approaches have been recognized as a key CCA strategy.

Sustainable ecosystems management is therefore increasingly viewed as an effective approach for achieving both DRR and CCA priorities. Additionally, both the World Bank and IPCC recommend that adaptation programs integrate an ecosystem-based approach into vulnerability and DRR strategies. Yet in spite of these policies and recommendations for decision makers to invest in ecosystem management and restoration, in practice, there are still few concrete examples of ecosystem-based DRR. Policy makers are still questioning why investments in DRR should take into account ecosystems and ecosystem services, and whether there is value-added in applying ecosystems management for reducing disaster risk, including climate-related risk (Estrella and Saalismaa, 2010). While ecosystem management is not a new concept, further evidence is still needed to build the case and demonstrate how ecosystem management can be maximized for DRR and thus facilitate uptake by communities, disaster management practitioners, policymakers and decision makers (Estrella and Saalismaa, 2010). This publication is therefore an initiative to answer these questions and fill this policy- action gap by highlighting good practices and arguments for ecosystem-based DRR and CCA with a special focus on Europe.

KEY MESSAGES FOR EUROPEAN POLICY MAKERS

1. **New solutions are required to reduce disaster risk:** Traditional engineering approaches to reducing climate risks are insufficient, especially in densely populated Europe. Cross-sectoral collaboration, dialogues, practices and policies are required to achieve real progress in reducing disaster risk.

2. **More exposure and degraded ecosystems are leading to more risk:** High exposure, vulnerability, environmental degradation due to concentrations of people along rivers, coastal areas and steep terrain are increasing disaster and climate risks.

3. **Limits of physical engineering structures:** Recent extreme events have demonstrated the limits of physical infrastructure for protecting European populations and have also created a sense of false security, allowing people to live in exposed floodplains or coastal areas.

4. **Overlooked possibilities of natural infrastructure for protection:** Many ecosystems act as natural buffers, or "natural infrastructure" to absorb the energy of hazard events for flood abatement, slope stabilization, coastal protection and avalanche protection in addition to physical structures (where appropriate) and disaster preparedness measures. However, the importance of ecosystems as a critical part of disaster risk reduction (DRR) is often overlooked.

5. **Cost effectiveness of natural infrastructure:** Natural infrastructure is often less expensive to install or maintain, and can offer equal protection to physical engineering structures, such as dykes, levees, or concrete walls, depending on the state of the natural infrastructure and the intensity hazard events.

6. **Multiple benefits of ecosystems:** Ecosystems offer additional multiple benefits, such as carbon sequestration, water filtration and storage, aesthetics, recreation and well-being, values that are not easily quantifiable.

7. **Investing in disaster prevention and ecosystems requires political willingness:** Investing in prevention versus reacting to disasters requires political will, donor willingness and new political strategies that recognize the value of ecosystems and the need for long-term solutions to disaster risk reduction. The fact is that it costs less to prevent rather than clean up after a disaster.

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Purpose

The goal of this publication is to develop a more robust understanding of ecosystem-based approaches to disaster risk reduction (DRR) and climate change adaptation (CCA) in the European context, including the economic rationale, tools and practices, while contributing to the growing literature on this subject. It is the fruit of the Council of Europe's participation in the Partnership for Environment and Disaster Risk Reduction (PEDRR), a partnership of 14 international organizations and NGOs, working together to promote the role of ecosystems for DRR. PEDRR, established in 2008 by UNEP and UNISDR, seeks to gather scientific evidence on the multiple roles of ecosystems for reducing disaster risk and communicate this evidence to policymakers worldwide. This publication is intended to fill a science-policy gap on the role of ecosystems for DRR, specifically for Europe and the Council of Europe's member states. It provides the rationale for a more systemic approach to reducing disaster risk, exploring how ecosystem management can be incorporated in a "portfolio" of investments in both hard and soft solutions. Concrete examples are provided for how an "Ecosystem-based DRR approach" can be more fully integrated into European policies and practices, with a number of recommendations for European policy makers and the Council of Europe members. The study targets not only policy-makers, but also land use planners seeking long term solutions to CCA and disaster risk managers seeking immediate and medium term solutions for reducing disaster losses. It also serves as a challenge to the environmental community to fine-tune existing tools and instruments so they can add value by reducing vulnerability to hazard impacts. Integrating ecosystem management and DRR/CCA can occur only if people and organizations in various sectors make a collaborative effort. What is needed is an integrated effort by land use planners, civil protection, humanitarian and environmental agencies.

Focus and scope

This study is largely based on the 2010 PEDRR paper, "*Demonstrating the Role of Ecosystems-based Management for DRR*" (Estrella and Saalismaa, 2010) a review of the grey literature, including International Union for Conservation (IUCN) publications, the UNISDR "*Global Assessment Report*", the "*IPCC Special Report on Extreme events, 2012*", the Global Network of Civil Society Organisations for Disaster Reduction (2011) "*Views from the Frontline*" Council of Europe policy documents and European Union directives and scientific studies. It focuses on how ecosystem services and ecosystem-based approaches can be integrated with DRR and CCA approaches, with emphasis on long-term planning and prevention. It synthesizes the current state of knowledge and practice in ecosystems-based DRR and examines the following key questions:

- What is our conceptual understanding of ecosystem-based DRR? What are the key elements?
- What are the available tools and entry points (opportunities) for promoting ecosystems-based DRR? How have they been applied, in which contexts?
- What are the limits and challenges in applying such integrated approaches?
- What are the enabling conditions and factors that facilitate effective implementation?

Although the literature review draws from experiences and case examples from Europe, this publication is intended as an overview of main issues of this evolving field and should be regarded as work-in-progress, as concepts, ideas and applications continue to be developed and tested. One of the main challenges with ecosystem-based DRR is that similar approaches may have been undertaken but without necessarily labeling them as such. Another is the often piecemeal nature of ecosystem management and DRR/CCA, where the two may be addressed separately but rarely together, or in a systematic manner.

This report is divided into four sections:

1. Introduction and rationale: Why an ecosystem-based approach to DRR and CCA?
2. Challenges: The European and context with regards to DRR and CCA:
   - The disaster situation in Europe and outlook;
   - The International and European policy framework;
3. Solutions: Ecosystem-based disaster risk reduction for DRR and CCA:
   - Case studies of common hazards and ecosystem responses;
   - Existing tools, methodologies, models and gaps for assessing ecosystems for DRR and CCA;
4. Conclusions and recommendations for action

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1. INTRODUCTION AND RATIONALE

European policy makers are already faced with difficult decisions about which investments are needed to face a changing climate but often opt for "hard engineering" options over "softer" investments, such as wetlands to provide natural reservoirs for excess water, coastal vegetation, protection forests, in addition to better preparedness, early warning systems and post-disaster recovery strategies. The European disaster risk reduction (DRR) and climate change adaptation (CCA) context presents a number of specific challenges to policy makers, mainly related to concentrated populations near major rivers. The sheer scale of risks posed by climate change and variability, in conjunction with globally widespread ecosystems decline, requires solutions that are cost-effective but also locally accessible and applicable. Exposure, one of the major drivers of risk is difficult but not impossible to reduce in densely populated Europe. Physical structures, especially dykes, have been erected in most European cities and provide significant protection to urban areas. Oftentimes, hybrid solutions are possible, combining both engineered structures with so called "natural infrastructure", as long as the engineered structures do not interrupt natural processes.

Depending on the territorial context, both engineered and natural infrastructure have their advantages and disadvantages. Both have limitations to the amount of energy they can absorb from "physical hazards". Physical engineered structures are limited by their age, quality of materials and location relative to the physical hazard. Natural infrastructure is limited by its relative degradation, amount of space accorded to an ecosystem on one hand and the amount of energy released by a hazard on the other hand. For example, a wetland may be effective in absorbing excess flood waters but only if accorded enough space to hold the additional water. Physical barriers may have the disadvantage of acting as "false security" for populations who may over-rely on engineered structures for protection. Natural infrastructure, on the other hand, provide other multiple benefits in addition to protection, many that cannot be quantified, such as aesthetics, recreational opportunities, a sense of well-being or fresh air, especially in densely populated urban areas. The bottom line is that investing in natural infrastructure can be considered a "low-regrets" strategy with additional advantages to European populations besides their protective role. Yet, ecosystem-based strategies are often overlooked by decision makers as cost-effective and effective components of disaster risk and climate change policies and practices.

Fortunately, the policy context over the past five years has evolved to include ecosystem-based strategies for DRR and CCA, although more progress is needed. The latest IPCC SREX report lists investing in ecosystems as "low-regrets" measures alongside early warning systems; risk communication between decision makers and local citizens; sustainable land management, including land use planning; and ecosystem management and restoration. The 2011 and 2009 Global Assessment Reports (UNISDR, 2009; UNISDR, 2011) listed environmental degradation as one of the main drivers of risk. During the course of UNFCCC negotiations for a global climate agreement and in particular since the Conference of Parties (COP) in Copenhagen in 2009, ecosystem-based approaches have been recognized as a key CCA strategy.

Although not a new approach, sustainable ecosystems management is therefore increasingly viewed as an effective approach for achieving both DRR and CCA priorities. Additionally, both the World Bank and IPCC recommend that adaptation programs integrate an ecosystem-based approach into vulnerability and DRR strategies. Yet in spite of these policies and recommendations for decision makers to invest in ecosystem management and restoration, in practice, there are still few concrete examples of ecosystem-based DRR. Policy makers are still questioning why investments in DRR should take into account ecosystems and ecosystem services, and whether there is value-added in applying ecosystems management for reducing disaster risk, including climate-related risk (Estrella and Saalismaa, 2010). While ecosystem management is not a new concept, further evidence is still needed to build the case and demonstrate how ecosystems management can be maximized for DRR and thus facilitate uptake by communities, disaster management practitioners, policymakers and decision makers (Estrella and Saalismaa, 2010). This publication is therefore an initiative to answer these questions and fill this policy-action gap by highlighting good practices and arguments for ecosystem-based DRR and CCA.

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2. CHALLENGES

2.1 The disaster situation in Europe and outlook

According to the European Environment Agency (2010) natural hazards and technological disasters caused nearly 100,000 fatalities and affected more than 100 million people between 1998 and 2009. Natural and technological disasters are estimated to cost €15 billion a year to the European economy, depending on the size of events during the year (EC, 2011). Among the events resulting in the largest overall losses were the floods in Central Europe in 2002 (over € 20 billion), in Italy, France and the Swiss Alps in 2000, (approximately € 12 billion) and in the United Kingdom in 2007 (over €4 billion) as well as winter storms over Central Europe in December 1999 (over € 18 billion) (EEA, 2010). The 2003 heat wave alone is estimated to have caused some 35,000 deaths, mainly among the elderly, along with a total economic loss of € 13 billion for the agricultural sector in Europe (Parry et al., 2007). Europe is naturally prone to disasters, given that a large part of its population lives concentrated along rivers, coastal areas, at times below sea level, in steep mountainous areas, tectonic and volcanic areas and extremely fire prone regions. The 2003 European heat wave, large scale flooding in the 1990s and 2000s in Central Europe, Netherlands, Germany and U.K., the 1999 wind storm in France, Atlantic storm Cynthia, forest and peat land fires in Russia in 2010, etc. have demonstrated that Europe and adjacent regions are highly prone to extreme hazard events.

Parry et al. (2007) attribute the 2003 heat wave to climate change, aggravated by existing vulnerabilities, in this case lack of adequate oversight of elderly populations. Even before the 2003 disaster, "natural" and "technological" disasters affected more than 7 million people in Europe and caused at least €60 billion in insured losses during the period 1998-2002 (Grieving et al. 2006). The combined effects of extreme heat and smoke pollution in Russia (Goldammer, 2010) resulted in increasing mortality and contributed to the increase of deaths in Russia which in July and August 2010 increased by 55,800 compared to 2009 (Goldammer, 2011). Disasters also have significant environmental impacts, which then affect long-term recovery. Extreme storms and fires can destroy large tracks of forests and other natural habitats, thus affecting the plants and animal species in their path. Floods can cause toxic substances found in the soil to infiltrate water aquifers, earthquakes can trigger fires and explosions, and droughts are likely to seriously affect water quality.

The recent Intergovernmental Panel on Climate Change (IPCC) Special Report on Extreme Events (SREX) policy summary reports with high confidence that a substantial warming has already occurred in Europe as counted by the number of warm days and nights (IPCC, 2012) (Text box 1). This trend is predicted to increase even further by the end of

Modified from IPCC, 2012

1

The current climate change situation in Europe

IPCC, Special Report on Extreme Events, Summary for Policy Makers, 2011

- Anthropogenic influences have led to **warming of extreme daily minimum and maximum temperatures** on the global scale and with high confidence for Europe.
- There are statistically significant trends in the **number of heavy precipitation** events in some regions, with strong regional and sub-regional variations in these trends.
- There is medium confidence that some regions of the world have experienced **more intense and longer droughts**, in particular in southern Europe and West Africa.
- There is limited to medium evidence regarding **the magnitude and frequency of floods** at regional scales because the available instrumental records of floods at gauge stations are limited in space and time, and because of confounding effects of changes in land use and engineering.
- There is **an increase in extreme coastal high water** related to increases in mean sea level due to climate change.

the 21st century, in parallel with an increase in the frequency of heavy precipitation, rising sea waters and heat waves in Europe (Text box 2). IPCC (2012) predicts a shift in mean temperatures for the 21st century from a previous "normal" baseline to a future climate baseline with more extreme record cold and record hot days. In spite some model uncertainties, climate warming is expected to increase the frequency and intensity of rainfall events, slope instabilities, drought and higher coastal water levels for most regions. The report also states that many extreme weather and climate events continue to be the result of natural climate variability, in addition to the effect of anthropogenic changes in climate. Moreover, small cumulative effects of disasters can be equally devastating by affecting livelihoods options, i.e. the cumulative effects of drought (IPCC, 2012).

Above all, the IPCC SREX (2012) report clearly highlights the importance of exposure and vulnerability as main drivers of risk, amplified by changing climate conditions:

"Increasing exposure of people and economic assets has been the major cause of the long-term increases in economic losses from weather- and climate-related disasters (high confidence). Long-term trends in economic disaster losses adjusted for wealth and population increases have not been attributed to climate change, but a role for climate change has not been excluded (medium evidence, high agreement)" (IPCC, 2012, p. 7).

2

Summary of predicted climate change trends for Europe in the 21st century

From IPCC, Special Report on Extreme Events, Summary for Policy Makers

- Increases in the **frequency and magnitude of warm daily temperature extremes and decreases in cold extremes** are likely to occur on the global scale, leading to increasing length, frequency and/or intensity of warm spells, or heat waves, over most land areas.
- Increases in the **frequency of heavy precipitation** or the proportion of total rainfall from heavy falls over many areas of the globe, especially in the high latitudes and tropical regions, and in winter in the northern mid-latitudes.
- Medium confidence that there will be a reduction in the number of extra-tropical cyclones averaged over each hemisphere with a **medium confidence projection of a poleward shift of extra-tropical storm tracks**.
- Medium confidence that **droughts will intensify in some seasons and areas**, due to reduced precipitation and/or increased evapotranspiration in southern Europe and the Mediterranean region, central Europe, central North America, Central America and Mexico, northeast Brazil, and southern Africa.
- Medium confidence (based on physical reasoning) that projected increases in **heavy rainfall would contribute to increases in local flooding**, in some catchments or regions.
- Very likely that mean sea level rise will contribute to upward trends in **extreme coastal high water levels** in the future.
- High confidence that changes in heat waves, glacial retreat and/or permafrost degradation will affect high mountain phenomena such as **slope instabilities, movements of mass, and glacial lake outburst floods**.

Modified from IPCC, 2012

2.2 Addressing Disaster and Climate Risks

The Hyogo Framework for Action (HFA) 2005-2015 – Building the Resilience of Nations and Communities to Disasters, calls on governments to: "adopt, or modify where necessary, legislation to support DRR, including regulations and mechanisms that encourage compliance and that promote incentives for undertaking risk reduction and mitigation activities as the first priority for action (HFA, Priority 1)". In 2005, 168 states signed a non-binding agreement to voluntarily report bi-annually on progress toward HFA goals. The HFA is facilitated by UN's International Strategy for Disaster Reduction (UNISDR) and provides an umbrella under which effective strategies for DRR can be coordinated and from which accountability can be derived (UNISDR, 2005).

According to UNISDR (2009), climate change will increase disaster risk by increasing the vulnerability of communities to physical hazards in two ways: **through ecosystem degradation**, reductions in water and food availability, and **changes to livelihoods** from increasing numbers of weather and climate hazards. More long-term investments in DRR are clearly warranted, yet the willingness to act long-term is usually scarcer than the resources to do so. Furthermore, according to the UNISDR 2011 Global Assessment Report, states have made progress toward disaster preparedness and response, governance and institutional arrangements and risk identification. However, the area where signatory states have reported the least progress is in addressing "underlying risk factors" (i.e. land use planning, poverty, environmental degradation) (Figure 1).

3

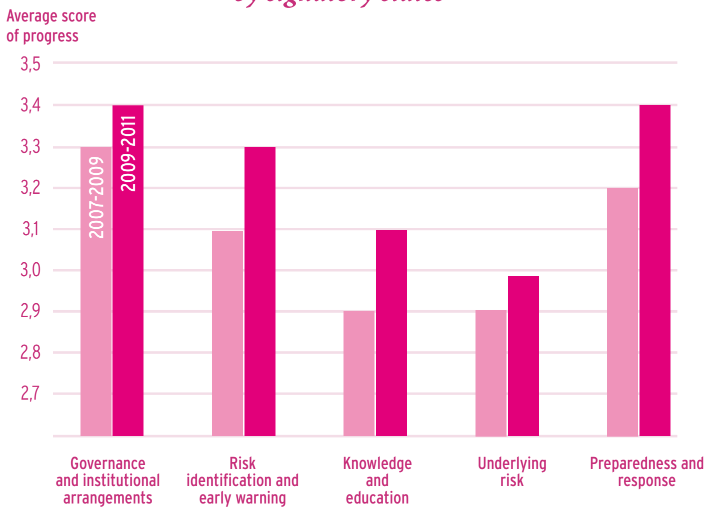
The Hyogo Framework Agreement - Priorities for action 2005-2015

Priority area 1. Ensure that DRR is a national and local priority with a strong institutional basis for implementation;
Priority Area 2. Knowledge of risk at national and local level;
Priority Area 3. Use knowledge, innovation and education to build a culture of safety and resilience at all levels;
Priority Area 4. Reduce the underlying risk factors;
Priority Area 5. Strengthening disaster preparedness for effective response.

www.preventionweb.net

1

Reported progress toward HFA Priority Areas by signatory states

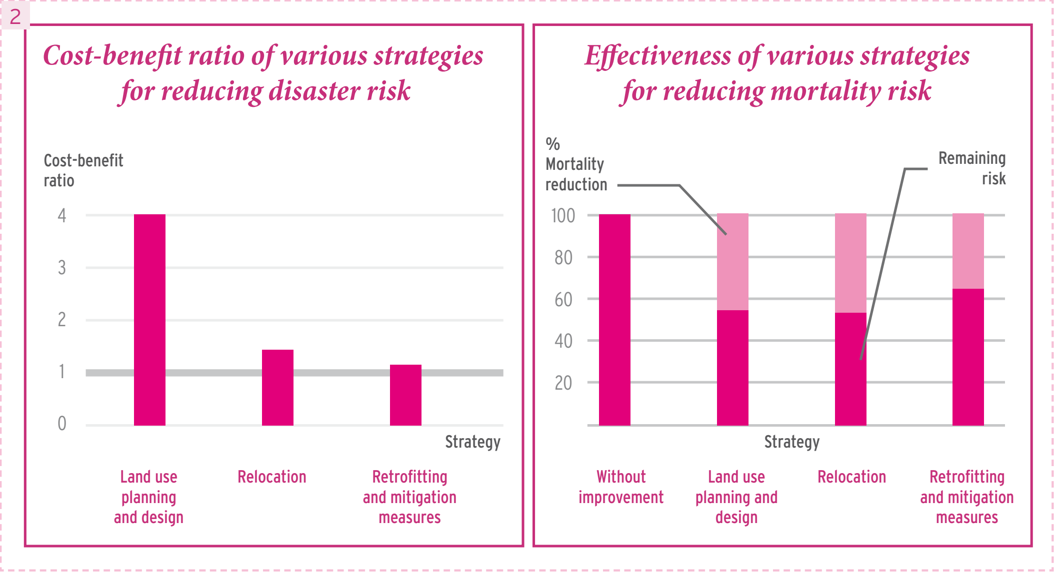


UNISDR, 2011

Hence, UNISDR (2011) demonstrates that it is land use planning and design which are the most cost-effective strategies for reducing disaster risk as compared to relocation and retrofitting mitigation measures (Figure 2). Land use planning is also an effective strategy for reducing mortality risk, alongside relocation and retrofitting measures.

Thus, what is required is a spectrum of long term investments in both "hard investments" to protect critical infrastructure, such as schools and health facilities, retrofitting buildings, relocating settlements and restoring ecosystems, or better yet, avoiding risky development in the first place and "soft investments" in capacities (i.e., disaster preparedness, early warning, monitoring, contingency planning) (Estrella and Saalismaa, 2010; Llosa and Zodow, 2011). The "hard investments" are expensive and require both political and financial commitments, which is probably why more progress has been made in investing in "soft investments". Usually, in order for commitments to become reality, regulations and incentives are required that are rooted in legislation with a broad political basis and enforceable. According to Llosa and Zodrow (2011), legislation and its enforcement enables and promotes sustainable engagement, helps to avoid disjointed action, at various levels, obliges bureaucracies to overcome inertia and provides recourse for society when things go wrong.

The next section provides an overview of current European legislation, programs and initiatives in the fields of DRR/CCA and ecosystem management. Although Europe is in many regards a leader in the environment field, the challenges are still great in terms of integrating environmental and disaster risk reduction legislation.



Adapted from ERN-AL, 2011

2.3 International Policy Context: Linking DRR, CCA and Environment

Internationally, a major challenge is the disconnect between DRR, CCA and Environmental frameworks, legislation, policies and terminology. According to Llosa and Zodow (2011), efforts have recently been made to link the international frameworks and legislation for climate change. In the Bali Action Plan (2008), the Parties to the United Nations Framework Convention on Climate Change (UNFCCC) recognize the links between DRR and climate change. In 2010, the UNFCCC Cancun Adaptation Framework formally recognized DRR as an essential element of CCA and encouraged governments to consider linking adaptation measures to the Hyogo Framework for Action (UNFCCC 2010, Paragraph 14(e) in Llosa and Zodow, 2011). The IPCC SREX (2012) summary for policy makers has further lessened gaps between the two fields by revising its previously distinct terminology to harmonize definitions with UNISDR terminology and highlighting the important role of ecosystems for both DRR and CCA.

On the international environmental arena, several agreements indirectly support or mention DRR goals (Llosa and Zodow, 2011), i.e., the Convention on Biological Diversity (1992), the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal (1989), the Convention on the Protection and Use of Transboundary Watercourses and International Lakes (Water Convention) (1992), and the Ramsar Convention on Wetlands (1971), the Convention to Combat Desertification (1994) and Agenda 21 (1992), the UNESCO World Heritage Convention (1972). However, more progress is needed to promote more integrated DRR by linking these three previously separate spheres, environment, DRR and CCA in order to ensure a more comprehensive, cross-sectoral approach through the implementation of international agreements.

2.4 European Policy Context: Linking DRR, CCA and Environment

In spite of Europe's significant legislative advance in integrative approaches to DRR and CCA, many challenges remain. To improve coordination among EU states on DRR, the **EU Civil Protection Mechanism** was enacted in 2007 (EC, 2007). This mechanism encourages states to develop approaches and procedures to risk management, such as risk mapping, risk assessments and analyses covering potential major natural and technological disasters. In 2010, the EC issued another guidance on risk assessments and will be issuing guidelines on minimum prevention standards by the end of 2012 (UNISDR et al., 2011). However, it is not clear whether this guidance will include ecosystem components for DRR and CCA. And in spite progress in Europe on prevention of disasters, according to Llosa and Zodrow (2011) there is more to be accomplished:

"Even in countries with well-developed legal systems, such as Germany and Austria, competencies allocated to different actors at the federal and provincial levels and the lack of coordination and coherence between a magnitude of individual risk-reducing laws in different sectors and different provinces jeopardize more effective risk reduction". (Fuchs, Holub 2009, as quoted by Llosa and Zodrow, 2011).

However one of EU's most progressive directives for integrating ecosystem management with DRR is the **Water Framework Directive** (EC 2000), which was enacted in 2000. It recognizes that a structural approach to flooding cannot completely eliminate flood risk, together with concerns about the environmental impacts of hard river engineering. The Water Framework Directive in particular supports an **integrated approach to water and drought risk management**, implemented through its member states. It is one of the few directives with a dual ecological and DRR component, requiring that ecological standards be upheld for water management measures, i.e. regulating water quality and quantity

(DEFRA, 2008). The framework requires a good understanding of ecological science in order to achieve a balance between ecological requirements and the need for flood defense. This also means that any new works in rivers have to undergo a greater degree of environmental appraisal before approval and measures for flood reduction must also allow for good ecological status to be achieved (DEFRA, 2008).

Secondly, after a number of major floods struck Europe between 1998 and 2004, the **EC Flood Directive** (EC 2007) was enacted **to coordinate flood risk management**, especially with regards to transboundary water issues. It was also an attempt to address major deficiencies reported in the transposition of the Water Framework Directive into national law. The Flood Directive requires States to undertake flood hazard and flood risk maps and devise flood risk management plans by 2015 (Llosa and Zodrow, 2011). The binding nature of this legislation has led many States to revise their national flood legislation and increase their efforts in this field (Llosa and Zodrow, 2011).

The result of these two EC directives led to a number of country programs: "**Making Space for Water**", which promulgates the use of wetlands, peat bogs, and other natural spaces as reservoirs for excess water. A combination of environmental and economic arguments, together with legislation on ecosystem-based flood management have led to a powerful force for change in river management practices in recent years and has informed the development of an array of alternative, 'softer' approaches (Wharton and Gilvear, 2006). At the core of these 'new' approaches (more natural river designs, river restoration and more strategic integrated approaches) is the acceptance that "rivers are meant to flood and must have room to move" (Gilvear et al., 1995) a recognition that rivers are dynamic, and linked to their surrounding floodplain (Wharton and Gilvear, 2006). According to the EU's HFA progress report: implementation of these directives has facilitated EU members states' efforts to address simultaneously multiple processes that impact drought and flood risk, including agricultural policies and integrated water resource management, and land use (EC, 2000; EC, 2009a, as cited by Llosa and Zodrow, 2011).

4

On Flooding and Structural Measures

"Rising investment in structural measures has not been accompanied by reduced flood damages. In the USA, for example, despite increasing investment in structural flood prevention, economic losses due to flooding between 1925 and 1994 increased thirty times from US$ 100 million to US$ 3000 million even when allowance is made for inflation (Smith and Ward, 1998). Such rises have been explained by the increased floodplain development that structural flood defences encourage. Thus, following flood protection for Datchet on the River Thames in the 1970s 450 new homes were built on the floodplain in less than a decade (Neal and Parker, 1988)."

Wharton and Gilvear, 2006

5

On the "Making Space for Water" Program and "Making Space for People"

The U.K. Environment Agency estimates that over five million people and two million homes and businesses are currently at risk of flooding in England and Wales, with assets valued at £250billion. However, DEFRA's Making Space for Water 2004, is taking a holistic approach to management of risk from all forms of flooding (river, coastal, groundwater, surface run-off and sewer) and coastal erosion, and seeking to ensure the programme helps deliver sustainable development.

"To manage the risks from flooding and coastal erosion by employing an integrated portfolio of approaches which reflect both national and local priorities, so as:

- to reduce the threat to people and their property;
- to deliver the greatest environmental, social and economic benefit, consistent with the Government's sustainable development principles; and
- to secure efficient and reliable funding mechanisms that deliver the levels of investment required to achieve the vision of this strategy."

Ryedale Flood Research Group (2008) Making Space for People report

2.5 Other EU legislation and initiatives on hazards , disaster risk and climate change

Text box 6 summarizes pertinent legislation related to hazards, climate change and the environment. Each piece of legislation or recommendation has its strengths and weaknesses and in many cases can go further in integrating either a risk component or an ecosystem management perspective. For example, the EC directives on Environmental Impact Assessments and Strategic Impact Assessments are well established in most European countries, but can go further in integrating risk assessments. The EC recommendations on Risk Assessment and Mapping on the other hand do not mention mapping ecosystem components as a critical part of risk mapping.

The communication in 2009 on "Community approach on the prevention of natural and technological disasters" from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions is extremely useful in recognizing the need for local capacities to address disasters effectively. The document highlights the need for local capacity building, knowledge sharing, awareness raising, local early warning systems and dialogue. It falls short by a lack of discussion about how to foster greater community involvement in disaster risk reduction through local participation in ecosystem maintenance and restoration. More progress has been made in integrating ecosystem concerns and climate change in the European context. In 2009, The EU Ad Hoc Expert Working Group on Biodiversity and Climate Change White Paper on «Adapting to climate change: Towards a European framework for action», makes explicit reference to the close inter-relationship between climate change and biodiversity and the need for an integrated approach to policy development. The report recommends that EU and Member States shall «explore the possibilities to improve policies and develop measures which address biodiversity loss and climate change in an integrated manner to fully exploit co-benefits and avoid ecosystem feedbacks that accelerate global warming" (EU Ad Hoc Expert Working Group on Biodiversity and Climate Change, 2009). This report followed Europe's European Climate Change Programme (ECCP), in 2000 which set strict targets for reducing emissions.

Other initiatives include the EC Working Group on Floods which further supports the implementation of the Water Directive and Flood Directive; and a Water Scarcity and Drought Expert Group that inputs into a Temporary Expert Group on Climate Change and Water (EC 2009a) (Llosa and Zodrow, 2011).

6

European Commission Legislation on Hazards and Risks

Relevant EC Directives

- **Water Framework Directive** for community action in the field of water policy, 2000/60/EC
- **Flood Risk Directive** for the assessment and management of flood risks, 2007/60/EC
- EU Civil Protection Mechanism
- Directive on the identification and designation of **European critical infrastructures** and the assessment of the need to improve their protection, 2008/114/EC
- Directive on the **Control of major accident hazards involving dangerous substances**, 96/82/EC
- **Marine Strategy Framework Directive** establishes European Marine Regions on the basis of geographical and environmental criteria.
- Directive on **Environmental Impact Assessments** 85/337/EEC
- Directive on **Strategic Environmental Assessments** 2001/42/EC

EC Recommendations:

- EC White Paper on "**Adapting to climate change: Towards a European framework for action**" (2009)
- EC Staff Working Paper – **Risk Assessment and Mapping Guidelines** for Disaster Management (SEC,2010)
- A **Community approach on the prevention of natural and man-made disasters**, (EC, 2009b) A Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions, (COM(2009) 82 final)
- Increase **Europe's resilience to crises and disasters** - Action 2: An all hazards approach to threat and risk assessment (COM (2010) 673: Objective 5)
- Recommendation to include **forest fires in the priorities to be addressed** in the ongoing work on exchange of good practice and development of guidelines on risk assessment and mapping, and to continue and enhance the European Forest Fire Information System (EFFIS) (Council conclusions of 26 April 2010, Council document 7788/10, inviting the Commission)

Source: (SEC, 2010; EC, 2009b; http://eurocodes.jrc.ec.europa.eu

2.6 The EU Nature Conservation and Biodiversity Policy

Europe's nature conservation policy is built around two pillars: the Natura 2000 network of protected sites and the strict system of species protection across their natural ranges. The directives protect over 1000 animal and plant species and over 200 so called «habitat types» (e.g. special types of forests, meadows, wetlands, etc.), which are of European importance. With 25,000 sites, Natura 2000 now covers an area larger than any single Member State. It is the largest network of protected areas in the world and is one of the most significant achievements in EU environmental policy. In 2006, the EC Biodiversity Action Plan, identified what still is needed to halt biodiversity loss. The recent indicator-based assessment conducted by the EEA «Progress towards the European 2010 biodiversity target» states that "European biodiversity remains under serious pressure and our policy measures have been insufficient to halt its general decline" (EU Ad Hoc Expert Working Group on Biodiversity and Climate Change, 2009).

In addition, the Marine Strategy Framework Directive requires each Member State to develop strategies for their marine waters. The marine strategies must contain a detailed assessment of the state of the environment, a definition of «good environmental status» at regional level and the establishment of clear environmental targets and monitoring programmes (EU Ad Hoc Expert Working Group on Biodiversity and Climate Change, 2009).

2.7 Council of Europe agreements and initiatives

The European and Mediterranean Major Hazards Agreement (EUR-OPA) was established in 1987 by the Committee of Ministers of the Council of Europe as a platform for cooperation between the countries of Europe and those of the southern Mediterranean in relation to major natural and technological hazards. The main objectives are closer and more dynamic co-operation among member states in order to ensure better prevention, protection and organization of relief, recovery and reconstruction in the event of a major natural or technological disaster. The agreement has been signed by 26 member states of which 23 are members of the Council of Europe and three are from southern Mediterranean states.

Priority activities include:
Institutional, legislative and political to analyse member state's legislation on major hazards and encourage the establishment of national platforms.

- Build a risk reduction culture through university training and specialized training courses, the development of primary school materials and awareness building of the general public.
- Research, risk assessment, early warning by collecting and analyzing information related to risks and developing standardized methodologies.
- Efficient preparation and response by supporting coordinated regional approaches and promoting psychological assistance in emergency situations.

In addition to the EUR-OPA Agreement activities, its Committee of Permanent Correspondents has recently adopted a number of specific resolutions and recommendations on major hazards in issues connected to environmental hazards:

- Recommendation 2011 – 1 of the Committee of Recommendation 2011 - 1 of the Committee of Permanent Correspondents on information to the public on radiation risks.
- Recommendation 2011 - 2 of the Committee of Permanent Correspondents on preventing and fighting wildland fires in a context of climate change.
- Recommendation 2010 - 1 of the Committee of Permanent Correspondents on reducing vulnerability in the face of climate change.
- Resolution 2010 – 1 of the Committee of Permanent Correspondents "Working together in Europe and the Mediterranean for the Prevention of Disasters, Preparedness and Response: Priorities for Action"

Other EUR-OPA initiatives include:

- International Colloquy, "The Rhine and Danube: preventing risks of pollution and flooding, a comparative analysis of the two catchment areas", November, 2001
- The LuCCA Initiative "Programme for an agreement for the Mediterranean Basin in the field of prevention, protection and organization in the case of natural disasters linked to flash flooding", Lucca, Italy, November 2002
- A contribution to the 4th International Wildland Fire Conference in Sevilla, Spain, May 2007, "Vegetation Fire Smoke: Nature, Impacts and Policies to Reduce Negative Consequences on Humans and the Environment" (Statheropoulos and Goldhammer, 2007 - http://www.fire.uni-freiburg.de/sevilla-2007/Council-Europe.pdf)

The Bern Convention on Conservation of European Wildlife and Natural Habitats
The Bern Convention is a 1979 Council of Europe treaty in the field of nature conservation which aims to conserve wild flora and fauna and their natural habitats and to promote European co-operation in that field. The Convention protects at the European scale endangered natural habitats and endangered and vulnerable species, including migratory species. It has been ratified by 45 European States, 4 African states and the European Union. All these 50 parties take common action to promote national policies for the conservation of wild flora and fauna, and their natural habitats and carry out European projects on protection of vulnerable species, fight against invasive alien species and other issues. Parties also are under the obligation to have regard to the conservation of wild flora and fauna in their planning and development policies, and in their measures against pollution.

Apart from protecting species, the Bern Convention launched in 1999 a very ambitious ecological network for Europe, the Emerald Network of "areas of special conservation interest", which takes to the whole of Europe and some countries of Africa the same principles embedded in the Natura 2000 network of the European Union. The Emerald Network is currently in its implementation phase, being developed in Switzerland, Iceland and into two specific regions, South-East Europe, where 80 % of the potential emerald sites have been identified, and in a network of states of Eastern Europe and the Caucasus, including Armenia, Azerbaijan, Belarus, Georgia, Moldova, Ukraine and the European part of the Russian Federation, where identification of potential sites of the Emerald Network is well advanced or completed.

2.8 Other European initiatives

Perhaps the most important study linking ecosystem-based approaches with climate change is the abovementioned EU Ad Hoc Expert Working Group on Biodiversity and Climate Change White Paper (2009). The working group is comprised of Member State representatives, staff of the European Commission, scientists and civil society. The White paper is primarily targeted at decision makers in the fields of climate change and biodiversity at the national, regional and international level including the European institutions. It does not however mention the links between ecosystems, climate change and disaster risk reduction, a major shortcoming of this document.

Another important initiative is the Green and Blue Space Adaptation for Urban Areas and Eco Towns (GRaBS) project. The GRaBS project is a network of leading pan-European organisations involved in integrating climate change adaptation into regional planning and development. The project has been co-financed by the European Union's Regional Development Fund (ERDF) and made possible by the INTERREG IVC Programme. The main role of this project is to promote the use of green infrastructure for climate resilience development (i.e., gardens, parks, productive landscapes, green corridors, green roofs and walls and blue infrastructure such as water bodies, rivers, streams, floodplains and sustainable drainage systems). According to GRaBS, green infrastructure plays "a vital role in creating climate resilient development – a role, which is currently not sufficiently recognised and utilised and lacks integration in mainstream planning" (GRaBS, 2011).

Other examples of European initiatives with an integrated ecosystem approach – DRR are France's "Grenelle de l'environnement", or environment roundtable, with legislation that brings multiple competing stakeholder groups together to develop policies that can reduce flood and risks in a coherent manner (Llosa and Zodrow, 2011) and the "Managed Realignment" programme along some coasts of England and Germany, which "involves setting back the line of actively maintained defences to a new line inland of the original – or preferably to rising ground – and promoting the creation of inter-tidal habitat between the old and new defences" (Rupp and Nicholls, 2002).

3. SOLUTIONS: WHY AN ECOSYSTEM APPROACH TO DRR AND CCA?

3.1 Main principles

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 (Sudmeier-Rieux and Ash, 2009).

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).

Ecosystems are crucial for DRR and CCA on two levels: for prevention and post-disaster recovery, in fact for every step of disaster management. Figure 3 Illustrates "*The disaster management spiral*" as an alternative to the more commonly used "*disaster management cycle*" where one always returns to the hazard event (RICS, 2009). What the disaster management spiral suggests is that with improved development planning, on-going risk reduction and sustainable development, it is possible to reduce the hazard event impact from becoming a disaster. Ecosystem-based DRR is required at each step of the disaster management spiral, from early post-disaster recovery, to reconstruction, risk and vulnerability assessments, and on-going disaster prevention through sustainable development.

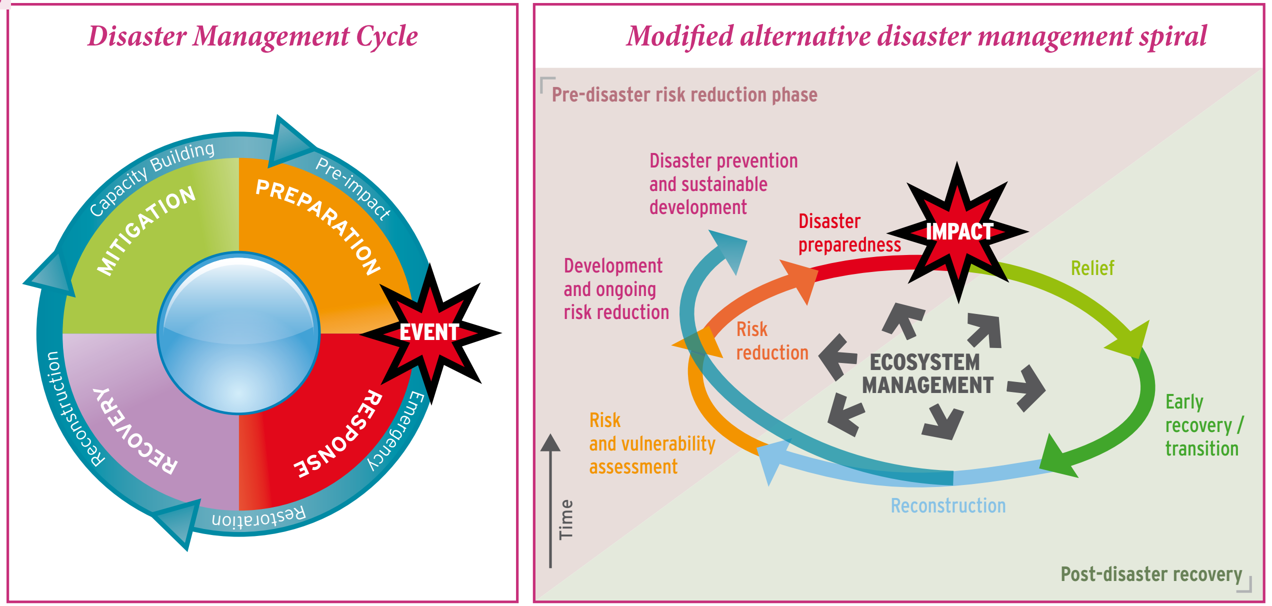
7

Urban resilience and watershed management

A watershed encompasses the land area that water flows across or through on its way to a shared stream, river, lake, estuary or ocean. Also referred to as catchment basins, watersheds capture and store water from the atmosphere, but also release water slowly or rapidly through various water bodies. Watersheds provide a wide range of goods and services to both urban and rural populations and play an important role in supporting urban life and development. Increasing or preserving tree coverage in upland zones helps maintain water quality and quantity in urban areas located downstream. Today at least one third of the world's biggest cities, such as, Singapore, Jakarta, Rio de Janeiro, New York, Bogotá, Madrid and Cape Town draw a significant portion of their drinking water from forested catchment areas. Well-managed, healthy watersheds maintain water run-off, reduce erosion, filter sediments and polluting materials, stabilize slopes and stream banks and in many cases reduce the occurrence of shallow landslides and floods. Watersheds are also a source of economic goods that are vital to livelihoods and economies, and provide spaces for recreation and cultural heritage.

(PEDRR, 2011b)

3



RICS, 2009

"*Ecosystem- based disaster risk reduction refers to decision-making activities that take into consideration current and future human livelihood needs and biophysical requirements of ecosystems, and recognize the role of ecosystems in supporting communities to prepare for, cope with, and recover from disaster situations*"
(Modified from Sudmeier-Rieux and Ash, 2009).

UNISDR has recognized that ecosystem-based disaster management policies, practices and guidelines need to be an integral part of DRR policies and practices. In fact, ecosystem management is central HFA priority 4, "reducing the underlying risk factors" (also see section 2.2). 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). Hence, 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 (Sudmeier and Ash, 2009).

While the terms **ecosystems** and **environment** are related and often used inter-changeably in the literature, a distinction is made here between these two concepts. Ecosystems are a dynamic complex of plant, animal and micro-organism communities and their non-living environment interacting as a functional unit (Convention on Biological Diversity, 1992). Ecological systems provide services and goods, providing a range of goods and other benefits necessary to support life, livelihoods and human well-being. On the other hand, the term environment is often applied in a more generic sense, which can include ecosystems but also refer to the physical and external conditions, including both natural and human-built elements, which surround and affect the life, development and survival of organisms or communities. In this paper, both terms are used but with a greater focus placed on ecosystems, as this perspective enables a more encompassing approach to the sustainable management of natural resources and ecosystem services for risk reduction.

"Sustainable ecosystems" or "healthy ecosystems" imply that ecosystems are largely intact and functioning, and that human demand for ecosystem services does not impinge upon the capacity of ecosystems to maintain future generations. Yet, according to Millennium Ecosystem Assessment (2005), approximately 60 percent of all ecosystem services and up to 70 percent of regulating services are being degraded or used unsustainably. 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)

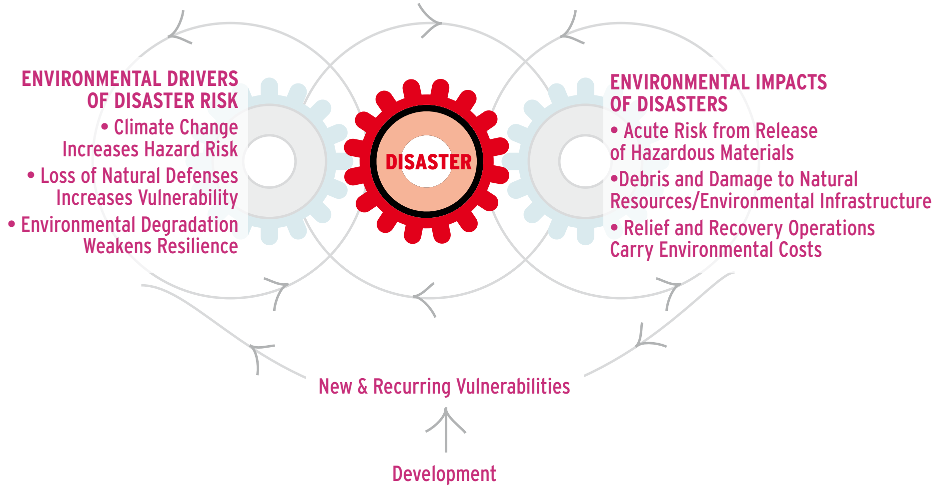
Ecosystem degradation and loss have led to serious impacts on human well-being: these include reduced availability of goods and services to local communities, increased spread of diseases and reduced economic opportunities. This, in turn, is leading to loss of livelihoods, and reduced food security (Miththapala, 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 is 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, 2009).

Estrella and Saalismaa, 2010

4

Environmental causes and consequences of disasters



3.2 Linking ecosystems, disasters and climate change

That the environment, development and disasters are linked is now widely accepted. What is less understood is the multi-dimensional role of the environment in the context of disasters, and how environment-disaster linkages in turn are affected by and can also shape development processes and outcomes (Figure next page).

Disasters can have adverse consequences on the environment and on ecosystems in particular, which could have immediate - to long-term effects - on the populations whose life, health, livelihoods and well-being depend on a given environment or ecosystem. Environmental impacts may include:

- direct damage to natural resources and infrastructure, affecting ecosystem functions,
- acute emergencies from the uncontrolled, unplanned or accidental release of hazardous substances especially from industries, and
- indirect damage as a result of post-disaster relief and recovery operations that fail to take ecosystems and ecosystems services into account.

As a result, pre-existing vulnerabilities may be exacerbated, or worse, new vulnerabilities and risk patterns may emerge especially in circumstances where there are cumulative impacts due to recurring natural hazards.

On the other hand, environmental conditions themselves can be a major driver of disaster risk, as highlighted by the 2009 Global Assessment Report. Degraded ecosystems can aggravate the impact of natural hazards, for instance by altering physical processes that affect the magnitude, frequency and timing of these hazards. This has been evidenced in areas like Haiti, where very high rates of deforestation have led to increased susceptibility to floods and landslides during hurricanes and heavy rainfall events. In the US, the devastation caused by Hurricane Katrina in 2005 was exacerbated due to canalisation and drainage of the Mississippi floodplains, decrease in delta sedimentation due to dams and levees, and degradation of barrier islands.

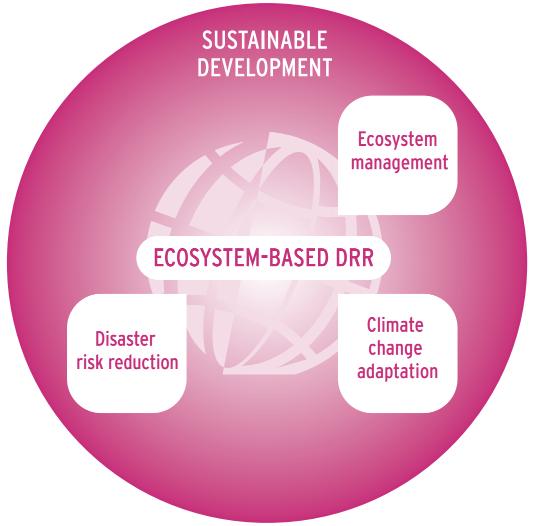
Most healthy ecosystems are naturally resilient after a stress event if it is not prolonged or repeated. Human-induced stresses, however, such as loss of habitat, unsustainable forest practices, overgrazing and extreme hydro-meteorological events resulting from climate change, lead to irrevocable disturbance to ecosystems. This in turn can cause irreversible loss of biodiversity. Changes in ecosystems will affect the supply of water, fuel wood and other services that affect human health and agricultural production (IPCC, 2012). Extreme climate conditions will lead to reduced biodiversity, reduced ecosystem protection, and inevitably, increased human vulnerability to natural hazards (Sudmeier-Rieux et al., 2006).

Figure 5. illustrates the connections between ecosystem management, development planning and disaster risk management. Although they each have their own specific set of stakeholders, goals and actions, a number of goals and actions are inter-related, such as the overarching objectives of saving lives, human well-being and supporting livelihoods.

5

PEDRR training course, 2011

Ecosystem-based DRR:
linking Ecosystem management, DRR, CCA
within sustainable development



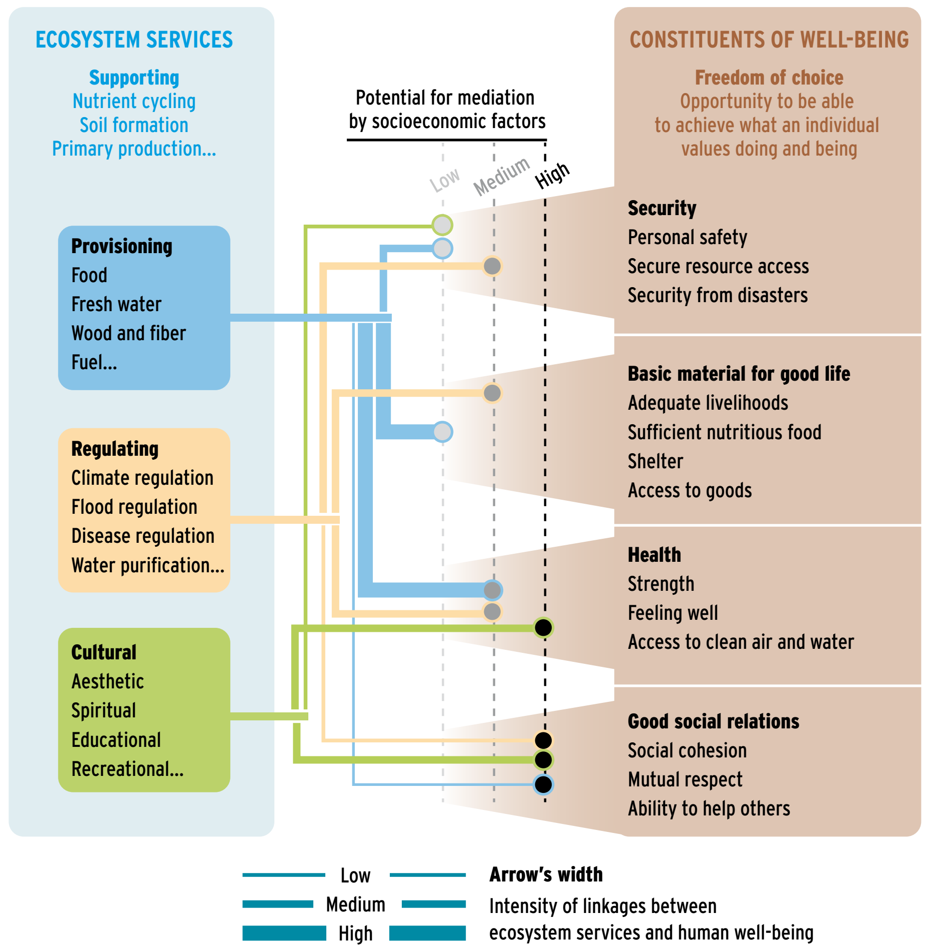
3.3 How can ecosystem services reduce disaster risk and climate change?

The benefits that people derive from ecosystems, or "ecosystem services", are often categorised into four types (Figure 6):

- **supporting services:** these are overarching services necessary for the production of all other ecosystem services such as production of biomass, water cycling and carbon sequestration;
- **provisioning services:** or "ecosystem goods" to support livelihoods;
- **regulating services** that offer protection and otherwise regulate the environment in which people live;
- **cultural services:** these are services supporting spiritual values, aesthetic, educational and recreational needs (Millennium Ecosystem Assessment, 2005).

6

Ecosystem services and human well-being



modified from Millennium Ecosystem Assessment,2005

Many experiences from around the world point to the potential benefits of ecosystems for DRR. Ecosystems, such as wetlands, forests and coastal systems, can reduce physical exposure to natural hazards by serving as natural protective barriers or buffers and thus mitigating hazard impacts. Well-managed ecosystems can provide natural protection against common natural hazards, such as landslides, flooding, avalanches, storm surges, wildfires and drought. For example, in the European Alps, mountain forests have a long history of being managed for protection against avalanches and rockfall. In Switzerland national guidelines for protection forest management have been developed collaboratively with local forest managers and scientists, and the state provides financial incentives to manage forests for hazard protection (see case study on protection forests). Several countries in Europe, such as Germany, the Netherlands, the UK, Eastern European countries bordering the Danube River, and Switzerland aim to mitigate floods through "making space for water" initiatives that remove built infrastructure and restore wetlands and river channels to improve their water retention capacity (case study on Danube River Basin restoration).

In other words, **ecosystems contribute to reducing disaster risk in numerous ways, providing multiple benefits and services** (Figure 7 and Table 1 page 30), **such as:**

- **regulating services:** ecosystems act as "natural infrastructure" for absorbing energy from physical hazard events (regulating service). The natural infrastructure will only be effective if healthy and adequate in proportion to the energy of a hazard event (i.e. poorly maintained protection forests are unlikely to prevent high magnitude avalanche from occurring). Yet, this also holds true for engineered structures, i.e. seawalls and dykes are not always adequate for withholding large magnitude hazards;
- **provisioning services:** ecosystems support livelihoods for reducing vulnerability. This holds true especially in developing countries but European populations are also dependent on natural resources for firewood, clean water, irrigation, well-being;
- **supporting services:** ecosystems support soil formation, nutrient cycling, or the basis for agriculture and livelihoods;
- **cultural services:** many culturally valuable sites, such as National Parks house important wetlands, mountain forests, coastal vegetation, which may buffer hazard events.

7

Multiple benefits of Ecosystems

modified from PEDRR training course, 2011

Estrella and Saalismaa, 2010

1 *Ecosystems and regulating services for hazard mitigation, or natural infrastructure*

Ecosystem	Regulating services - hazard mitigation
Mountain forests and other vegetation on hillsides	• Vegetation cover and root structures protect against erosion and increase slope stability by binding soil together, preventing landslides. (1) • Forests protect against rockfall and stabilise snow reducing the risk of avalanches. (2) • Catchment forests, especially primary forests, reduce risk of floods by increasing infiltration of rainfall, and delaying peak floodwater flows, except when soils are fully saturated. (3) • Forests on watersheds are important for water recharge and purification, drought mitigation and safeguarding drinking water supply for some of the world's major cities. (4)
Wetlands and floodplains	• Wetlands and floodplains control floods in coastal areas, inland river basins, and mountain areas subject to glacial melt. (5) • Peatlands, wet grasslands and other wetlands store water and release it slowly, reducing the speed and volume of runoff after heavy rainfall or snowmelt in springtime. • Coastal wetlands, tidal flats, deltas and estuaries reduce the height and speed of storm surges and tidal waves. (6) • Marshes, lakes and floodplains release wet season flows slowly during drought periods.
Coastal ecosystems, such as mangroves, saltmarshes, coral reefs, barrier islands and sand dunes	• Coastal ecosystems function as a continuum of natural buffer systems protecting against hurricanes, storm surges, flooding and other coastal hazards - a combined protection from coral reefs, seagrass beds, and sand dunes/coastal wetlands/coastal forests is particularly effective. (7) Research has highlighted several cases where coastal areas protected by healthy ecosystems have suffered less from extreme weather events than more exposed communities. (8) • Coral reefs and coastal wetlands such as mangroves and saltmarshes absorb (low-magnitude) wave energy, reduce wave heights and reduce erosion from storms and high tides. (9) • Coastal wetlands buffer against saltwater intrusion and adapt to (slow) sea-level rise by trapping sediment and organic matter. (10) • Non-porous natural barriers such as sand dunes (with associated plant communities) and barrier islands dissipate wave energy and act as barriers against waves, currents, storm surges and tsunami. (11)
Drylands	• Natural vegetation management and restoration in drylands contributes to ameliorate the effects of drought and control desertification, as trees, grasses and shrubs conserve soil and retain moisture. • Shelterbelts, greenbelts and other types of living fences act as barriers against wind erosion and sand storms. • Maintaining vegetation cover in dryland areas, and agricultural practices such as use of shadow crops, nutrient enriching plants, and vegetation litter increases resilience to drought. (12) • Prescribed burning and creation of physical firebreaks in dry landscapes reduces fuel loads and the risk of unwanted large-scale fires.

(1) Dolidon et al (2009), Peduzzi (2010), Norris et al (2008), Sudmeier-Rieux et al. (2011). (2) Bebi et al (2009), Dorren et al (2004). (3) Bradshaw et al (2007), Krysanova et al (2008). (4) See World Bank 2010. (5) Campbell et al (2009). (6) Batker et al (2010), Costanza et al (2008), Ramsar (2010a), Zhao (2005). (7) See, for example Badola et al (2005), Batker et al (2010), Granek and Ruttenberg (2007). (8) Campbell et al (2009), Ramsar (2010b), UNEP-WCMC (2006), World Bank (2010). (9) Mazda et al (1997), Möller (2006), Vo-Luong and Massel (2008). (10) Campbell et al (2009). (11) Intergovernmental Oceanographic Commission (2009). (12) Campbell et al (2009), Krysanova et al (2008).

3.4 A cost-effective and "no-regrets" approach to DRR and CCA

One of the most important arguments for ecosystem-based DRR is that it is a cost-effective component of DRR and CCA investments. It is suggested that the regulating services of ecosystems may form the largest portion of the total economic value of ecosystem services, although they are also, along with cultural services, the most difficult to measure in economic terms (TEEB, 2010). Some examples of the value of natural hazard mitigation are presented in Table 2, although it is important to note that ecosystem service values are often very context specific. For example, the role of a coastal vegetation to protect against extreme weather events can be vital or marginal, depending on the location of the community. In consequence, the value of a service measured in one location can only be extrapolated to similar sites and contexts if suitable adjustments are made. In spite of the difficulties, approximate estimates of ecological valuation, as compared to structural infrastructure, can be useful to guide resource management decisions.

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
- Bequest values: the willingness to pay to ensure that future generations inherit a particular environmental asset.

Non-use values

- Intrinsic values: i.e. the value of biodiversity in its own right independent of value placed on it by people.

(Modified from Emerton and Bos, 2004)

There are three basic types of monetary or financial valuation methods: direct market valuation; **indirect market valuation; and survey-based valuation** (i.e. contingent valuation and group valuation). If no site-specific data can be obtained (due to lack of data, resources or time) benefit transfer or **replacement costs** can be applied (i.e. using results from other, similar areas, to approximate the value of a given service in the study site). Replacement costs refer to the cost that would be incurred should a valuable ecosystem (i.e. coral reefs) be destroyed and have to be replaced by an engineered structure (i.e. seawalls), or the cost of rebuilding infrastructure (i.e. roads, housing) that is no longer protected by ecosystems (i.e. forests on mountain slopes) (DeGroot, 2011). For example, along the coast of Indonesia, the cost of replacing roads and houses in the event of strong waves is estimated at US$50,000/km, and the cost of maintaining sandy beaches for tourism is US$1 million/km, both are protected and maintained naturally by coral reefs (Emerton, 2009), saving society large sums of money.

Estrella and Saalismaa, 2010

2 *Estimated economic value of ecosystem services for natural hazard mitigation* (20)

Ecosystem	Hazard	Hazard mitigation value (US$)
Coral reefs (global)	coastal	189,000 per hectare/year (13)
Coral reefs (Caribbean)	coastal	700,000– 2.2 billion per year (total value) (14)
Coastal wetlands (United States)	hurricane	8,240 per hectare/year (15)
Coastal wetlands (United States)	storms	23.2 billion per year (total value) (16)
Luz_ice floodplain (Czech Republic)	floods	11,788 per hectare/year (17)
Muthurajawela marsh (Sri Lanka)	flood	5 million per year (total value); 1,750 per hectare/year (18)
Coastal ecosystems (Catalonia, Spain)	disturbance protection, including storms	77,420 per hectare/year (19)
Mountain forests (Switzerland)	avalanche / rock fall	1,500-2,500/km/ha (Wehrli and Dorren forthcoming)

(13) TEEB (2009). (14) Conservation International (2008) (15) Costanza et al (2008). (16) Costanza et al (2008). (17) ProAct Network (2008). (18) Emerton and Bos (2004), see also Emerton and Kekulandala (2003). (19) Brenner et al (2010). 20) These examples have used different valuation approaches, such as the avoided damages approach, or comparing natural infrastructure to alternative human-built structure such as a reservoir. See TEEB (2009) and www.teebweb.org for further discussion on approaches to economic valuation of ecosystem services.

3.5 Tools and approaches for ecosystem-based DRR and CCA?

This section provides an overview of the full range of environmental tools and instruments available that could be used to integrate environmental concerns and ecosystems-based approaches as part of DRR. Most of these tools and approaches have existed for decades but have not often been combined to integrate ecosystem and DRR functions. These tools include the following:

1. Environmental assessment tools:
Environmental impact assessments (EIAs) and strategic environmental assessments (SEAs) are the best-known tools for undertaking environmental assessments to inform policy, programme or project development. They allow information on social, economic and environmental impacts to be considered, resulting in a much more integrated assessment process. While practical experience remains very limited, EIAs and SEAs are being adapted to analyze disaster risk-related factors associated with the potential threats to and consequences from proposed projects, programmes, plans or policies. Rapid Environmental Assessments (REAs) are generally applied to assess the environmental situation in the aftermath of a disaster and quickly provide data to support decisions, paying close attention to water and sanitation, potable water supplies, solid and disaster debris management, safe handling of hazardous substances, site selection of temporary camps, and procurement of building materials.

2. Integrated risk and vulnerability assessments:
although there are many risk and vulnerability assessment methodologies, most do not adequately identify the changes to risk and vulnerability that are attributable to ecosystem conditions and environmental change, including climate change. As a result, assessment methodologies often fail to identify critical aspects of risk and vulnerability affected by ecosystem conditions and thus do not sufficiently address environmental risk drivers nor consider ecosystem-based risk reduction options. To fill this gap, UNEP developed RiVAMP methodology, which integrates ecosystem conditions into risk maps (Text box 8).

3. Spatial planning at regional and local scales:
Spatial planning can draw upon any or all of the above tools and approaches and encompasses comprehensive, coordinated planning at all scales, from national to local, aiming at an efficient and balanced territorial development. Spatial planning operates on the presumption that the conscious integration of sectors such as transport, housing, water management, etc. is likely to be more efficient and effective than uncoordinated programmes in the different sectors (Grieving et al., 2006). Thus, the core element of spatial planning is to prepare and make decisions about future land use, referred to as land use planning at the local level (Grieving et al, 2006). In order to promote sustainable development, it is indispensable to mitigate hazards, a task where spatial planning can play an important role. Hence according to a 2006 study by Grieving et al., (2006) of spatial planning practices in Europe, risk management aspects play only a minor role in spatial planning decisions: "an integrated planning approach is missing". Spatial planning can be considering the master plan into which ecosystems management can be integrated.

4. Integrated ecosystems management
Common denominators of these approaches is their multi-stakeholder component and focus on dialogue-building for both improved natural resources management and risk reduction.

- **Integrated water resources management:** Integrated water resource management (IWRM) is a process, which promotes the coordinated development and management of water, land and related resources in order to maximize the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems. In terms of disaster risk reduction, IWRM is relevant for managing both excess water (i.e. flood and landslide mitigation) and water scarcity (i.e. drought management). IWRM approaches can help to build a strong flood mitigation strategy by combining sustainable management of ecosystems (restoration of wetlands, forest and river basin management) with overall land-use planning for the area. It can also be particularly useful in managing transboundary river basins and watersheds, such as in the case of the Alpenrhein River that runs through Switzerland, Austria and Lichtenstein.

- **Integrated coastal zone management:** In coastal areas, integrated coastal zone management (ICZM) (also, 'integrated coastal area management' - ICAM) provides a multi-sectoral framework for the sustainable management of coastal zones and resources. It considers fragility of coastal ecosystems, the entire spectrum of cross-sectoral uses, their impacts and the trade-offs needed to ensure sustainable development. In Europe there is a move towards integrated coastal zone management (i.e. beach nourishment using dune grasses, and U.K., through a realignment of coastal wetlands to buffer coastal wave energy) (DEFRA, 2005; Deltacommissie, 2008).

- **Integrated fire management:** Enhances capacities to address wildfire hazards together with other social, economic and ecological sustainability concerns in a given area. In the South Caucasus countries Armenia, Azerbaijan and Georgia, fire management practices are introduced to build the social and ecological resilience of local communities (see case study on fire management in the South Caucasus) (Goldammer, 2010). Several countries in Europe are using prescribed burning both for decreasing wildfire hazards and for biodiversity and forest management objectives, and there is growing interest for better use and integration of traditional fire use and management.

- **Protected area management:** Protected areas encompass a wide range of ecological spaces and include national parks, nature reserves, wilderness areas, wildlife areas, protected landscapes as well as community conserved areas, with differing governance systems. Over 120,000 designated protected areas now cover approximately 13.9 percent of the Earth's land area. Marine protected areas cover 5.9 percent of territorial seas and 0.5 percent of the high seas and are gradually increasing in number and size. Although protected areas are expanding globally, under-protection and significant encroachment of protected areas are leaving many sites extremely exposed and vulnerable to hazards. Protected area professionals therefore need to consider the added value of protected areas for disaster prevention and mitigation when planning, managing and advocating for protection.

- **Community-based Ecosystem and Disaster Risk Management:** Although in Europe responsibility for risk has mainly been transferred to government agencies, local people are still often the first on site during a hazard event before search and rescue teams arrive. Especially in rural areas of Europe, local populations still possess a wealth of traditional knowledge both on ecosystem management and disaster risk reduction. Studies demonstrate that even in wealthy countries, disaster risk reduction strategies are much more effective when involving communities in both community based sustainable natural resources management and disaster risk management (Kuhlicke et al., 2011). Examples include community participation in maintaining protection forests, coastal protection, keeping waterways clean of debris, or maintaining terraces on steep slopes. Community-involvement in the prevention and self-defense of rural communities against wildfires is a common approach practiced in many countries (http://www.fire.uni-freiburg.de/Manag/CBFiM.htm).

UNEP, 2010

8

Risk and Vulnerability Assessment Methodology

The Risk and Vulnerability Assessment Methodology Development Project (RiVAMP) is a methodology, developed in 2010 by the United Nations Environment Programme, which takes into account environmental factors in the analysis of disaster risk and vulnerability. While there are different types of risk and vulnerability assessments, what is new about RiVAMP is that it recognizes ecosystems and climate change in the risk assessment process. The purpose of RiVAMP is to use evidence based, scientific and qualitative research to demonstrate the role of ecosystems in disaster risk reduction, and thus enable policymakers to make better-informed decisions that support sustainable development through improved ecosystems management. In this regard, the targeted end-users of RiVAMP are national and local government decision makers, especially land-use and spatial development planners, as well as key actors in natural resource and disaster management.

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4. HAZARDS AND ECOSYSTEM RESPONSES TO REDUCING RISK OF DISASTERS AND CLIMATE CHANGE IMPACTS

4.1 Flooding

Case study: Floodplain restoration in the Danube Delta for flood reduction

Description

Over the last century, floodplains of the Danube and its tributaries were subject to major human interventions which caused significant changes in the hydromorphology of the river-floodplain ecosystem and losses of natural values and processes. During this time, an estimated 68% of floodplains were lost. However, the political changes in Central and Eastern Europe and respective EU policies, as well as the Ramsar Convention on Wetlands are fostering efforts to re-establish the lateral connectivity of floodplains along the Danube and its major tributaries through restoration projects. In the past two decades, thousands of floodplain restoration projects have been under planning and implemented in various sizes and with different purposes and levels of success. WWF International has recently inventoried existing projects and prioritized remaining areas for restoration.

Floodplain restoration area (implemented, planned, proposed) along the Danube and major tributaries

source : wwf

Actions taken

- An inventory of existing floodplain restoration sites was undertaken based on already existing government and non-governmental projects and proposals, or 439 floodplain areas of a total size of 1.38 million ha with major existing, planned and proposed restoration projects were collected and analysed for their restoration potential.
- Out of the 439 sites, 58 restoration projects have already been implemented (122,710 ha total; or 3,700 ha mean size), 105 are under official planning (662,910 ha) and the remaining 276 are being proposed (590,195 ha), mainly in former floodplains.
- In addition, new areas for restoration were proposed from the upper Danube to the Delta based on available data including: land use and habitats (settlements are “no go” areas), spatial configuration (size/length/width/position), hydromorphological intactness, overlapping protected areas, and floodplain function/purpose.

Lessons learned

- It is necessary to increase trans-boundary knowledge of Danube River Basin floodplains overall, and to extend continuous floodplain assessment based on floodplain segments by country.
- Type-specific and adaptive restoration strategies are needed. Protection and restoration of existing floodplains is important, as only about 10% remain under near-natural conditions along upper and middle Danube.
- Favorable legal frameworks, e.g. clear protection of still-existing retention areas (no-go areas for further land development in floodplains), strong spatial planning instruments and tight administrative and political structures that allow for transparent public participation are requirements for successful restoration projects.
- Broad stakeholder involvement and interdisciplinary planning work is a pre-condition for successful restoration.

Source

WWF-Int and Fluvius (2010) Assessment of the restoration potential along the Danube and main tributaries

4.2 Wildfires

Case study : Fire management in the South Caucasus

Description

In Europe, recurrent wildfires are most common in the Mediterranean and the eastern temperate-boreal regions. Recent climate extremes, associated with traditional socio-economic and land-use changes have favored increasing occurrence and severity of wildfires in regions, which until recently had not been exposed to high wildfire risk. Technological solutions alone cannot reduce the environmental, economic and human losses: there is a need to identify alternatives, e.g. integrated fire management solutions to increase socio-economic and ecological resilience to address extreme climate and wildfires. In the South Caucasus (SC), the extent of damage of the wildfires is attributed to the limited capacity in fire management of agencies that deal with fire prevention and response. Not only do fires pose an immediate risk to the population but can have serious consequences in terms of increased threats of landslides, mudflows or floods - especially in mountain regions and also an additional source of contention between countries.

Actions taken

A project entitled “Enhancing National Capacity on Fire Management and Wildfire Disaster Risk Reduction in the South Caucasus” was launched after 2006 under the support through the Environment and Security (ENVSEC) Initiative and implemented through the Global Fire Monitoring Center (GFMC). The project aims to improve the capacity of the South Caucasus countries to efficiently respond to the wildfires, through improved forest fire management, and to assist countries in defining national forest fire management policies and implementation strategies. The project also seeks to enhance regional co-operation in fire management, supported by finances by the EUR-OPA Secretariat.

The work on site in Armenia, Georgia and Azerbaijan builds on several steps:

- Interviews and hearings of local communities and government institutions, to assess wildfire hazard, reasons and causes, occurrence and impacts and organization of a National Round Table on Fire Management, to identify need for action and to initiate a multi-level national dialogue towards drafting a national fire management policy;
- Encourage communities and agencies responsible for land and management and conservation to identify approaches and solutions for increasing resilience of ecosystems and land-use systems at various levels (landscape and local levels) in fire management (active participation of local government and civil society in the prevention, preparedness and control of wildfires; defense of villages and other rural assets and values at risk against wildfires);
- Support strategic planning for implementing a national fire management policy including investment at various levels to build sustainable capacity in fire management at the most critical levels.

Lessons learned

- Stakeholder discussions and national round tables revealed a broad consensus in the three SC countries that participation and responsibility in the protection of forests and other vegetation resources against degradation or destruction, including prevention and defense of wildfires, must be shared with civil society, notably at community level;
- Increasing public awareness on the needs of environmental protection is key for public acceptance for an empowerment of civil society towards concrete action, i.e. through volunteer fire protection units in countries that traditionally had relied on centralized responsibilities of government agencies and are now ready to change;
- Active involvement and support of national governments is essential for future development of relevant public policies and implementation strategies. Government support for active partnerships with civil society is needed.

Additional references:

- http://www.fire.uni-freiburg.de
- http://www.fire.uni-freiburg.de/GlobalNetworks/SEEurope/ENVSEC-OSCE-South-Caucasus-2012-Extract-Fire.pdf
- http://www.fire.uni-freiburg.de/GlobalNetworks/SEEurope/OSCE-Guide-CBM-Measures-2012-Extract-Fire.pdf
- http://www.nature-ic.am/en/Forest_Fire_Events_12_14.09.11

New forest firefighting equipment in Georgia

© GFMC

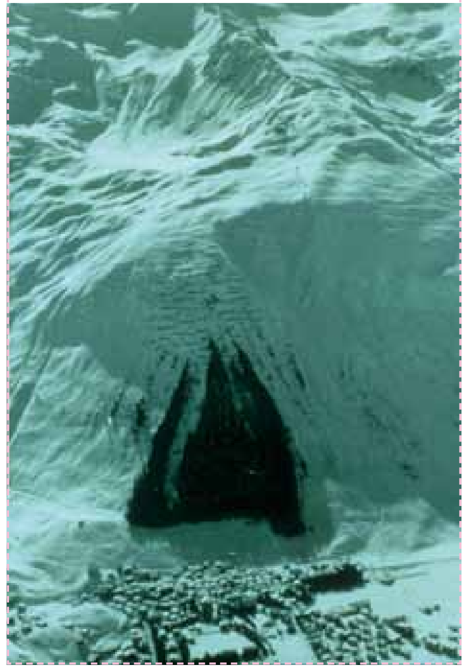
4.3 Mountain hazards: landslides, debris flow, rock fall and avalanches

Case study: Protection forests in Switzerland

Description

Many forests in the Alps protect people and their assets against mountain hazards such as rockfall, snow avalanches, erosion, landslides, debris flows and flooding (Brang et al., 2001). These hazardous processes are frequent in the Alps (EEA, 2010), which explains the relatively high proportion of protection forests in many alpine regions. According to the third Swiss National Forest Inventory, approximately 43% of Swiss forests have a direct or indirect protective function against natural hazards (Duc and Brändli, 2010). Protection forests play a key role in integrated risk management, as they have the capacity to reduce natural risks to acceptable levels at rather low cost (Wehrli and Dorren, forthcoming). The management of protection forests is approximately 5 to 10 times less expensive than the construction and maintenance of technical measures (Sandri, 2006 as quoted in Wehrli and Dorren, forthcoming).

Andermatt, Switzerland: protection forest



©WSL/SLF

Actions taken

Since protection forests are a key factor in integrated risk management in Switzerland, the management of these forests is being improved continuously to provide optimal protection against natural hazards. Protection forest management is based on the assumption that there is a direct link between the risk posed by natural hazards and the state of a forest. The goal of protection forest management is to ensure a forest is as effective as possible in reducing potential damage due to hazards. Currently, Switzerland invests approximately 160 million Swiss Francs per year in protection forest management (FOEN, personal communication with A. Sandri, 2012). The actions taken include nationwide delimitation of protection forests, silvicultural interventions and subsequent success monitoring. In many Alpine countries, the silvicultural interventions in protection forests are carried out following specific guidelines (Wehrli and Dorren, forthcoming), which are mostly based on the Swiss guideline "Sustainability and success monitoring in protection forests - NaiS" (Frehner et al., 2005). The concept of NaiS is based on a comparison of the current state of a forest with target profiles for natural hazards and site types, taking into consideration the natural forest dynamics.

Lessons learned

- Protection forests are a key factor in integrated risk management in the Alps, since they provide effective prevention and mitigation at rather low cost;
- Political support is key for ensuring the financial means needed for an effective and efficient nationwide protection forest management program;
- Protection forests need to be identified and subsequently managed in a sustainable way, based on guidelines. These guidelines have to be based on the current state of knowledge and conceptually sound. Consequently, they should continuously be subject to critical review and development.

All references are listed at end of publication.

Additional references:

- http://www.bafu.admin.ch/org/organisation/00180/00193/index.html?lang=en
- http://www.europe74.cg74.fr/index.php/programme-france-suisse/143-projet-qforets-de-protectionq
- http://www.foresteurope.org/eng/Commitments/Ministerial_Conferences/
- http://www.wsl.ch/index_EN

4.4 Coastal hazards: storms, flooding, rising sea level

Case Study: Freiston Shore Realignment Scheme in England

Description

Coastal defences at Freiston Shore protect low-lying land (much below sea level) in Lincolnshire, Eastern England, though were becoming increasingly eroded. 'Managed realignment' – the landward retreat of coastal defences and the creation of new saltmarsh habitat – has been promoted by the U.K. Department for Environment Food and Rural Affairs (DEFRA, 2002) to increase coastal resilience, reduce defence maintenance costs and create new intertidal habitat. After successful marsh re-establishment, Freiston Shore has experienced decreased erosion and become a popular tourist site, with more than 63 000 visitors a year. The site is now managed by the Royal Society for the Protection of Birds (Freiss et al., 2008).

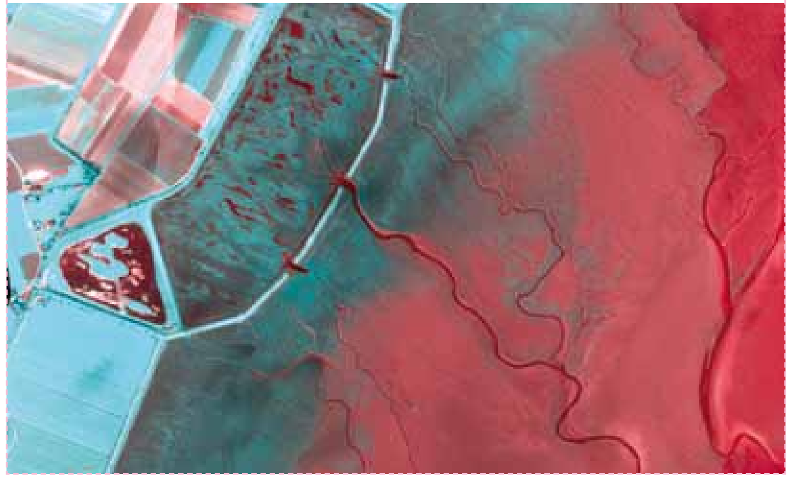
Actions taken

- Prior to breaching, a landward secondary sea wall was strengthened to provide protection during storms;
- Channels were excavated within the site to facilitate drainage and sediment delivery around the new marsh;
- A 15 ha saline lagoon was created to enhance the local coastal habitat and provide a secondary habitat for birds. This area is used by >10 000 roosting waders at high tide;
- Monitoring was funded for 5 years, conducted by the Centre for Ecology and Hydrology and the Department of Geography, University of Cambridge. Monitoring focused on vegetation dynamics, invertebrate populations and surface accretion. Additional data has also been collected by various MSc and PhD students such as airborne LiDAR topographic mapping, airborne remote sensing, data on water exchange and sediment tracing.

Lessons learned

- Freiston Shore has been one of the most successful realignments to date, and has highlighted the importance of correct site surface elevation for rapid marsh establishment;
- However, drainage was inadequately modeled during site preparation. A larger-than-expected increase in tidal exchange caused significant erosion at the breaches, releasing >63 000 m^3 of sediment onto the surrounding intertidal zone and affecting local geomorphology. Thus, it is important to consider wetland restoration schemes in the context of their surrounding environment;
- Effective communication with local stakeholders and integration into larger-scale management schemes is crucial. Sediment released from the site smothered a local oyster fishery that was not known to be in the vicinity of Freiston Shore.

Freiston Shore realignment site and fronting saltmarsh



Dan Friess, National University of Singapore

A false-colour multispectral image of the Freiston Shore realignment site and fronting saltmarsh (red) and mudflat (blue), 2003.

Sources:

DEFRA (2002). Managed Realignment Review. Project report. Halcrow Group, CSERGE, Cambrige Coastal Research Unit. Policy Research Project FD 2008

Friess DA, Spencer T & Möller I. 2008. Managed realignment and the re-establishment of saltmarsh habitat, Freiston Shore, Lincolnshire, United Kingdom. In: The Role of Environmental Management and Eco-Engineering in Disaster Risk Reduction and Climate Change Adaptation. ProAct Network/UN International Strategy for Disaster Reduction: Nyon

Additional references:

- http://www.abpmer.net/omreg/
- http://proactnetwork.org/proactwebsite/media/download/CCA_DRR_reports/casestudies/

4.5 Coastal hazards: storms, flooding, rising sea level

Case study: Making Space for Water – An Innovative Government Strategy for Flood and Coastal Erosion Risk Management in England

Description

As part of the U.K.'s Making Space for Water (MSfW) programme, an innovative country strategy for flood and coastal erosion risk management, the Slapton Coastal Zone Adaptation Plan was developed in South Devon. It aimed to develop and implement an innovative and sustainable community-based adaptation programme for the Slapton coastal zone. Slapton Sands, located seaward adjacent to the Slapton Ley Nature Reserve, is a five kilometre stretch of shingle beach facing east into Start Start Bay and the English Channel. It is vulnerable to coastal erosion as witnessed in 2001 when storms severely eroded the shingle barrier. The strong winds, high spring tides and low beach shingle levels closed off the main coastal road for three months, severing a vital link between Kingsbridge and Dartmouth. Nearby local communities, such as Torcross, were affected, as traffic was disrupted and several local businesses suffered losses.

Actions taken

The pilot initiative involved conducting a risk analysis of flood and erosion threats to property and infrastructure within the community of Torcross. An environmental evaluation of adaptation options involving community consultations concluded that it was not economically or environmentally acceptable to defend the road and beachhead from future erosion using engineered, coastal hard defences. Building a hard structure would interfere with beach geomorphology and cause accelerated erosion. Accommodating coastal change through managed retreat was identified as the overall long term solution. Funds were thus invested towards short-term community-driven solutions, such as the localised movement of shingle to provide temporary protection along short lengths of the road to repair storm damages. This was intended to prolong the life of the road and keep the damaged section of the sea defences protected. However, alternative options in preparation for the future permanent breach of the main coastal road were identified, including the landward realignment of specific sections of the main road in the event of future breaches. In addition, Slapton's coastal management policies were incorporated into the management plan of the Slapton Ley Nature Reserve, maximizing it for natural protection against coastal hazards as well as for eco-tourism and recreation.

Lessons learned:

- The MSfW is a proactive ecosystem-based approach towards flood and coastal erosion management that yield multiple benefits, including for local development (e.g. tourism) as well as biodiversity protection;
- In the past, there was heavy reliance on rigid, engineered structures for flood risk management along England's river banks and coastlines which required constant repair and costly upgrades;
- The new approach to risk management adopts the use of natural infrastructure and processes for hazard mitigation. This programme aims to address future development pressures and rising coastal hazards as a result of climate change and reduce mitigation costs;
- This MSfW programme also demonstrates that ecosystems and land-use decisions can be effectively managed for flood and coastal erosion mitigation;
- The challenge is how to replicate and scale-up these pilot efforts. External funding is still regarded as critical to successful project implementation;
- There is a need for long-term monitoring to measure the long-term flood mitigation benefits of the MSfW pilot initiatives;
- More approaches need to be explored and tested at field-level in order to identify best practices and the most effective flood mitigation options. Finally, the Government should continue to find ways to incorporate MSFW strategies across various sectoral and development policies.

Source:

Department for Environmental, Food and Rural Affairs, Environment Agency (DEFRA, 2005)

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5. CONCLUSIONS: CHALLENGES AND OPPORTUNITIES

This publication seeks to demonstrate that **ecosystem-based DRR and CCA** provide many opportunities for improving the prevention and recovery from disasters while buffering changing climate for several reasons:

- it ensures the rapid recovery of ecosystems on which livelihoods depend;
- it avoids disaster responses that have a negative impact on ecosystem recovery;
- it enhances communities' capacity to recover their livelihoods;
- it brings the greatest improvements to present-day livelihoods while minimizing the impact of future disasters;
- it offers a cost-effective, "no-regrets" approach.

Europe is in many regards a world leader when it comes to environmental legislation, policies and practices (i.e., the Green and Blue Space Adaptation for Urban Areas and Eco Towns (GRaBS) and NATURA 2000). However, the challenge in Europe and worldwide remains to integrate the often separate DRR, CCA and environmental arenas, even if real progress has been achieved through some EC legislation and country programmes over the past decade.

Another main challenge is the psychological reassurance offered by physical engineering structures versus natural infrastructure . This bias may be warranted in urban areas with very high population density yet "making space for water" may be possible when considering the entire river basin upon which urban areas depend. Moreover, physical structures can also act as false security attracting inappropriate settlements in flood plains directly behind dykes or seawalls. Physical structures are often erected in areas of high value, protecting one area at the expense of another, depending on which area is considered at highest risk. Thus agricultural fields, or areas with low income populations may be inundated to save adjacent urban centers – however with proper planning such scenarios can be minimized.

Hybrid solutions can also be considered, i.e. green belts and dykes, protection fences or seawalls, as long as the physical structures do not impede natural processes, such as natural sand replenishment along coastal areas. Even in densely populated European cities, it is possible to construct engineering structures alongside ecosystems, (i.e., developing green spaces where settlement is inappropriate, or wetlands around urban areas as reservoirs for excess water). Protection forests can be established in addition to gabion walls or rock fall nets (picture below). However, promoting ecosystems management as the only risk reduction strategy could also provide a false sense of security, similar to overreliance on physical structures. It should be considered as an often overlooked part of a diversified "DRR portfolio" in addition to early warning systems and disaster preparedness measures (Estrella and Saalismaa, 2010).

Example of hybrid protection solution

©Dorren, 2009

protection forests, gabion wall, protective nets along an Austrian mountain road.

In spite of Europe's forward-thinking legislation, it is not immune to the political difficulties of investing in prevention and long-term solutions, including ecosystem-based solutions versus hard engineering structures. There is still room for progress in mainstreaming ecosystem-based approaches into risk mapping, community awareness raising and capacity building and a more comprehensive approach to disaster risk reduction, which is still lacking in Europe. EC Directives and Recommendations, such as the Flood Directive, the Water Framework Directive EU and EC White Paper on Climate Change are in themselves innovative but do not go far enough in providing clear recommendations for integrating ecosystem management with disaster risk reduction, climate change adaptation.

Lack of funding is often blamed for shortcomings in policies and practices favoring a more integrated approach to DRR and CCA. This point is highlighted by the UNISDR 2011 Global Assessment Report, which states that the lack of efficient and appropriate budget allocations remains one of the major challenges for effective DRR legislation (UNISDR, 2011). Adequate funding is probably the ultimate litmus test of government commitment to DRR (Llosa and Zodrow, 2011). According to Benson (2009), the integration of disaster risk concerns into government budgets should be tackled from two angles, ensuring that levels of public expenditure on risk reduction are sufficient and that there are adequate financial arrangements to manage the residual risk (Llosa and Zodow, 2011).

Finally, the role of spatial planning for Europe's highly urbanized territories is critical and currently only plays a minor role in risk management and vice versa. The EU funded ARMONIA research project (2006), which assessed risk reduction methods in Europe, concluded that "an integrated planning approach is missing" (Greiving et al., 2006). Spatial planning is thus an area that is underutilized for disaster risk management and yet UNISDR considers it to have the highest potential for reducing disaster risk and mortality (UNISDR, 2011).

On a positive note, four key elements make favorable shifts toward positive DRR and CCA policies more likely:

- Major disasters;
- An active civil society to promote democratic political change;
- The engagement of particularly dynamic individuals;
- A well-educated and participative population.

Modified from UNDP (2007)

9

Summary of gaps in current DRR and CCA practices – the European context

- Lack of integrative legislation, policies and practices to include ecosystem management for a more systemic approach to DRR and CCA;
- Lack of consideration of natural infrastructure instead of or together with physical infrastructure;
- The need to include ecosystem services in risk mapping and risk assessments;
- The need for more cost-benefit analysis together with physical infrastructure;
- The need for more integrated spatial planning and multi-hazard projections;
- Lack of efficient and appropriate budget allocations to ensure that EC legislation and policies are enacted across Europe.
- Lack of integrated spatial planning which has high potential for incorporating ecosystem management with DRR and CCA.

Dan Friess, National University of Singapore

European populations have already experienced several major disasters, which provided the impetus for new legislation (e.g., the EC Flood Directive) and we are fortunate to have active civil societies and engaged, well-educated populations. Thus, in spite of the challenges, Europe is already on the path for more integrated ecosystem-based DRR and CCA policies and practices. Hopefully this publication has provided additional ideas for moving further along a sustainable and less disaster-prone pathway.

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6. KEY RECOMMENDATIONS: APPLYING ECOSYSTEM-BASED DRR AND CCA IN EUROPE

1. Recognize and promote the multiple functions and services provided by ecosystems at multiple spatial scales.

Ecosystems provide valuable services for hazard protection and regulation, which until now have been under-utilized by European programmes and strategies. Ecosystems serve as natural infrastructure that can reduce physical exposure and buffer energy from physical hazards. However, it is equally important to recognize ecosystems' contributions towards overall human well-being by sustaining rural economies, urban green spaces and strengthening resilience against hazard impacts.

Harnessing the potential of ecosystems for DRR should be based on rigorous understanding of the context-specific, ecological and technical requirements to enhance natural protection and hazard mitigation. Inadequate or ineffective natural buffers and physical structures can create a false sense of security and jeopardize the credibility of ecosystem-based DRR as a whole.

2. Analyse and promote the cost-effectiveness of ecosystem-based DRR and CCA.

Cost-benefit analyses of ecosystem services for hazard reduction as compared to engineered structures are clearly needed and should be part of spatial planning and any new development projects. Ecosystem valuation studies have clearly shown the value of ecosystems for regulating, provisioning, supporting and cultural services. Yet, there is a lack of economic valuation studies for hazard reduction in Europe to inform decision-making about the benefits and trade-offs between natural and physical infrastructure investments.

3. Combine investments in ecosystems with other effective DRR strategies as part of a diversified "DRR portfolio".

Investing in ecosystems is not a single solution to disasters but should be used in combination with other risk reduction measures, such as early warning systems and disaster preparedness. Ecosystem thresholds may be surpassed depending on the type and intensity of the hazard event and the health status of the ecosystem, which may provide insufficient buffering against hazard impacts. In some cases, combining ecosystem-based approaches with engineered structures may be necessary to protect critical assets especially in densely population urban areas.

4. Address both long-term and short-term climate risks with ecosystem-management.

Adopting an ecosystem-based DRR approach can strengthen long-term adaptation to climate variability as well as immediate hazard events. In contrast to degraded ecosystems, well-managed ecosystems are viewed to be more resilient to climate-related risks. Efforts to integrate DRR and ecosystems management should maximize ongoing work on CCA, i.e., through ecosystem-based approaches such as integrated water resource management.

5. Enhance governance capacities for ecosystem-based DRR through multi-sector, multi-disciplinary platforms and especially in spatial planning.

Europe is a leader with regards to progressive legislation on an integrative multi-hazards approach to flooding, spearheading several innovative programmes such as "making space for water", thus a shift towards ecosystem-based DRR is possible through adoption of national policies and legislation promoting natural infrastructure for risk reduction, as already demonstrated by several European countries. Such innovative policies have yet to reach all European countries at the national and local level.

In many cases, appropriate policies and legislation may be in place, but the main problem lies in their enforcement and the lack of political willingness to carry out programmes over the long-term. In order to facilitate cross-sectoral collaboration and stimulate innovative policies, strong multi-sectoral mechanisms or platforms are needed. It is particularly important to develop multi-disciplinary teams and involve people with different technical expertise and knowledge, for instance city engineers and land developers working together with ecologists and disaster management experts. This should apply both at national as well as sub-national levels. Multi-sectoral, multi-disciplinary mechanisms facilitate sharing of available data, help ensure scientific and technical rigour in designing and implementing ecosystem-based DRR initiatives and obtain the political support necessary to integrate them into national and local development plans. However, clear incentives are needed for such mechanisms to build consensus and work effectively.

6. Create financial incentives for ecosystem-based DRR and CCA.

A strong regulatory framework is certainly a first step for guiding innovative solutions and practices to DRR and CCA but are only effective if coupled with additional innovative financial incentives (e.g., restoration of wetlands may financially compensated, especially if near high risk zones). Risk transfer schemes (i.e. insurance or re-insurance companies) may be possible by investing in natural infrastructure for reducing risk. Another example are Payments for Ecosystem Services, where the value of ecosystems are transferred from consumers to producers (i.e. downstream water consumers pay upstream users for protecting water source). Financial incentives are often required for relocating settlements out of high-risk zones to the benefit of green spaces.

7. Involve local stakeholders in decision-making to ensure more sustainable solutions.

Local stakeholders clearly have a role to play in promoting risk reduction through sustainable ecosystems management. The EC has recognized the importance of local action (EC 2009b) for the prevention of natural and technological disasters and further action can be taken to incorporate ecosystem management concerns. This involves understanding local livelihood needs and priorities, risk perceptions, local knowledge, and involving local stakeholders in decision-making. Local communities are often direct resource users and their knowledge of local ecosystems can provide critical information in planning successful ecosystem-based DRR initiatives. Raising the awareness of local people by demonstrating the combined livelihoods and risk reduction benefits of ecosystem-based solutions is equally important in winning and sustaining local support.

8. Utilize existing instruments and tools in ecosystems management and enhance their DRR value.

A variety of tools, instruments and approaches used in ecosystem management (i.e. EIAs, protected area management, community-based natural resource management, integrated forest management) can be readily adopted and applied at country and community levels as part of disaster risk reduction strategies. What is needed is the improved and routine use of disaster risk information (e.g. types of hazards over time and space, socio-economic vulnerability profiles of communities, elements at risk, etc.) in the design of integrated ecosystem approaches to maximize their added value for DRR. For instance, rehabilitation of upland watersheds can be further harnessed for flood mitigation by improved understanding of the local hazards, hydrology, topography as well as socio-economic demands on forest products and the types of indigenous tree species that are best suited for reforestation activities. Also, considerable progress can be made in incorporating risk assessments into spatial planning tools (Greiving et al., 2006) and ecosystem management in Europe.

9. Link ecosystems-based risk reduction with sustainable livelihoods and development.

Even in Europe, poverty remains an issue and it is usually the poor and vulnerable who are at greatest risk and the least resilient to disasters (i.e. the 2003 heat wave and the elderly). While ecosystem-based disaster reduction should be an integral part of a long-term development strategy, demonstrating short-term tangible outcomes and benefits especially to communities will be critical to win and maintain stakeholder engagement.

10. Foster more science - policy - practitioner dialogues

There is still much to be learned about ecosystem services for DRR. More research is needed to better understand the performance thresholds of ecosystems and resilience against hazard events and climate change. There is even greater lack of economic valuation studies on the multiple values of ecosystems for hazard reduction. Nonetheless, given the challenges of fully monetizing ecosystem services, there should also be further development and testing of non-economic valuation methodologies. This includes evidence-based assessment methodologies, such as RiVAMP or interdisciplinary studies that combine local and expert knowledge to measure and quantify the role of ecosystems especially for hazard mitigation. Above all, it is crucial to transmit existing knowledge through guidelines to national and local governments on how to move forward in integrating ecosystem-based management with DRR and CCA, which is what this publication is about (modified from PEDDR, 2010).

Key recommendations

1. **Recognize and promote the multiple functions and services provided by ecosystems at multiple spatial scales.**
2. **Analyse and promote the cost-effectiveness of ecosystem-based DRR and CCA.**
3. **Combine investments in ecosystems with other effective DRR strategies as part of a diversified "DRR portfolio".**
4. **Address both long-term and short-term climate risks with ecosystem-management.**
5. **Enhance governance capacities for ecosystem-based DRR through multi-sector, multi-disciplinary platforms.**
6. **Create financial and legal incentives for ecosystem-based DRR and CCA.**
7. **Involve local stakeholders in decision-making to ensure more sustainable solutions.**
8. **Utilize existing instruments and tools in ecosystems management and enhance their DRR value.**
9. **Link ecosystems-based risk reduction with sustainable livelihoods and development.**
10. **Foster more science - policy - practitioner dialogues.**


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Recommendation

EUROPEAN AND MEDITERRANEAN MAJOR HAZARDS AGREEMENT (EUR-OPA)

Recommendation 2012 - 1 of the Committee of Permanent Correspondents on ecosystem-based disaster risk reduction, adopted at the 62nd meeting of the Committee of Permanent Correspondents of the European and Mediterranean Major Hazards Agreement (EUR-OPA), Strasbourg, France, 26-27 April 2012

The Committee of Permanent Correspondents of the European and Mediterranean Major Hazards Agreement (EUR-OPA),

A. Recognising the need to explore all possible ways to reduce disaster risk, combining traditional engineering approaches with solutions based on the maintenance or build up of natural infrastructures or buffers capable of reducing risks of flooding, erosion, landslides, snow avalanches, coastal risks and others;

B. Aware that eroded, degraded or badly managed ecosystem may increase the vulnerability of populations, particularly in mountain regions, rivers flood plains and coastal areas and that hazards in those areas may increase with global change, including climate change;

C. Desirous to promote new, cost effective solutions based on natural infrastructures as an alternative or a complement to more classical engineering ones, with the additional advantage of favouring ecological stability, water filtration and storage carbon sequestration, increasing aesthetic and recreational values of the areas treated;

D. Taking note with satisfaction of the report "Ecosystem Approach to DRR : basic concepts and recommendations to governments, with a special focus to Europe" by Dr. K. Sudmeier-Rieux (IUCN Commission on Ecosystem Management), and welcoming the participation of the Agreement in the Partnership for Environment and Disaster Risk Reduction (PEDRR);

Recommend that member States of the European and Mediterranean Major Hazards Agreement (EUR-OPA):

1. Continue to integrate progressively ecosystem-based solutions into national disaster risk reduction policies and practice, favouring as appropriate investment and landscape planning in prevention and long-term strategies that would reduce vulnerability;

2. Pursue the integration of disaster risk reduction into climate change adaptation policies promoting ecosystem-based DRR as a useful approach to help mitigation, protect people, and produce other benefits for populations;

3. Consider taking measures to improve the resilience of communities through ecosystem-based DRR such as those specified in Appendix 1 to this recommendation, and the use of tools and approaches such as those specified in Appendix 2 to this recommendation;

4. Support the efforts of the Agreement to promote ecosystem-based DRR in its Member States mainly through the organisation of specific training and the promotion of ecosystem based DRR in other fora.

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ACRONYMS

CCA	Climate Change Adaptation
DRR	Disaster Risk Reduction
GAR	Global Assessment Report
GFMC	Global Fire Monitoring Center
IPCC	Intergovernmental Panel on Climate Change
IUCN	International Union for Conservation of Nature
NGO	Non-Governmental Organisation
PEDRR	Partnership for Environment and Disaster Risk Reduction
SREX	Special Report on Extreme Events (IPCC)
UNEP	United Nations Environment Programme
UNISDR	United Nations International Strategy for Disaster Reduction
UNDP	United Nations Development Programme
UNFCCC	United Nations Framework Convention on Climate Change

GLOSSARY

This glossary of commonly used words in this publication draws upon sev eral sources, mainly from UNISDR and IPCC's new 2011 definitions, which reflect an effort to harmonize DRR and CCA definitions.

Adaptation: In human systems, the process of adjustment to actual or expected climate and its effects, in order to moderate harm or exploit beneficial opportunities. In natural systems, the process of adjustment to actual climate and its effects; human intervention may facilitate adjustment to expected climate (IPCC, 2012).

Biological diversity: The variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems (Convention on Biological Diversity, 1992).

Climate change: The United Nations Framework Convention on Climate Change (UNFCCC) defines climate change as change that can be attributed "directly or indirectly to human activity and that alters the composition of the global atmosphere, which is in addition to natural climate variability observed over comparable time periods". IPCC (2012) defines climate change as:" A change in the state of the climate that can be identified (e.g., by using statistical tests) by changes in the mean and/or the variability of its properties and that persists for an extended period, typically decades or longer. Climate change may be due to natural internal processes or external forcings, or to persistent anthropogenic changes in the composition of the atmosphere or in land use".

Disaster: Severe alterations in the normal functioning of a community or a society due to hazardous physical events interacting with vulnerable social conditions, leading to widespread adverse human, material, economic, or environmental effects that require immediate emergency response to satisfy critical human needs and that may require external support for recovery (UNISDR, 2009).

Disaster Risk: The likelihood over a specified time period of severe alterations in the normal functioning of a community or a society due to hazardous physical events interacting with vulnerable social conditions, leading to widespread adverse human, material, economic, or environmental effects that require immediate emergency response to satisfy critical human needs and that may require external support for recovery (IPCC, 2012).

Disaster Risk Reduction: The concept and practice of reducing disaster risks through systematic efforts to analyse and manage the causal factors of disasters, including through reduced exposure to hazards, lessened vulnerability of people and property, wise management of land and the environment, and improved preparedness for adverse events. (Source: UNISDR. 2009)

Ecosystem: A dynamic complex of plant, animal and micro-organism communities and their non-living environment interacting as a functional unit (Convention on Biological Diversity, 1992).

Ecosystem services: Ecosystem services refer to the goods and benefits derived from ecosystem functions; these include "provisioning services" such as food, water, timber and fibre; "regulating services" that affect climate, floods, disease, wastes and water quality; "cultural services" that provide recreational, aesthetic, and spiritual benefits; and "supporting services" such as soil formation, photosynthesis and nutrient cycling (Millennium Ecosystem Assessment, 2005)

Environment: Environment refers to the physical and external conditions, including both natural and human-built elements, which surround and affect the life, development and survival of organisms or communities.
(Estrella and Saalismaa, 2010)

Exposure: People, property, systems, or other elements present in hazard zones that are thereby subject to potential losses (UNISDR, 2009).

Hazard: A hazard is a dangerous phenomenon, substance, human activity or condition that may cause loss of life, injury or other health impacts, property damage, loss of livelihoods and services, social and economic disruption, or environmental damage (UNISDR, 2009). According to the UNISDR 2011 Global Assessment Report, hazards emanating from geological, meteorological, hydrological sources used to be referred to as "natural hazards" are now referred to as "physical hazards" as the effect of anthropogenic climate change may have changed the "natural" origin of such events.

Natural resources: Natural resources are actual or potential sources of wealth that occur in a natural state, such as timber, water, fertile land, wildlife and minerals. A natural resource qualifies as a renewable resource if it is replenished by natural processes at a rate comparable to its rate of consumption by humans or other users. A natural resource is considered non-renewable when it exists in a fixed amount, or when it cannot be regenerated on a scale comparative to its consumption (Estrella and Saalismaa, 2010).

Resilience: The ability of a system, community or society exposed to hazards to resist, absorb, accommodate and recover from the effects of a hazard in a timely and efficient manner that minimizes hazard impacts and contributes to reducing risk and vulnerability (UNISDR, 2009).
The ability to bounce forward and move on following a disaster (Manyena et al. 2011)

Risk: The combination of the probability of an event and its negative consequences (UNISDR, 2009). Risk is commonly expressed as a function of exposure, the conditions of vulnerability that are present, and the magnitude and frequency of a hazard event.

Vulnerability: The characteristics and circumstances of a community, system or asset that make it susceptible to the damaging effects of a hazard. Vulnerability is the result of the whole range of economic, social, cultural, institutional, political and even psychological factors that shape people's lives and create the environment that they live in. In other words, defining vulnerability also means understanding the underlying factors or root causes of vulnerability (UNISDR, 2009).
The propensity or predisposition to be adversely affected (IPCC, 2012).

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