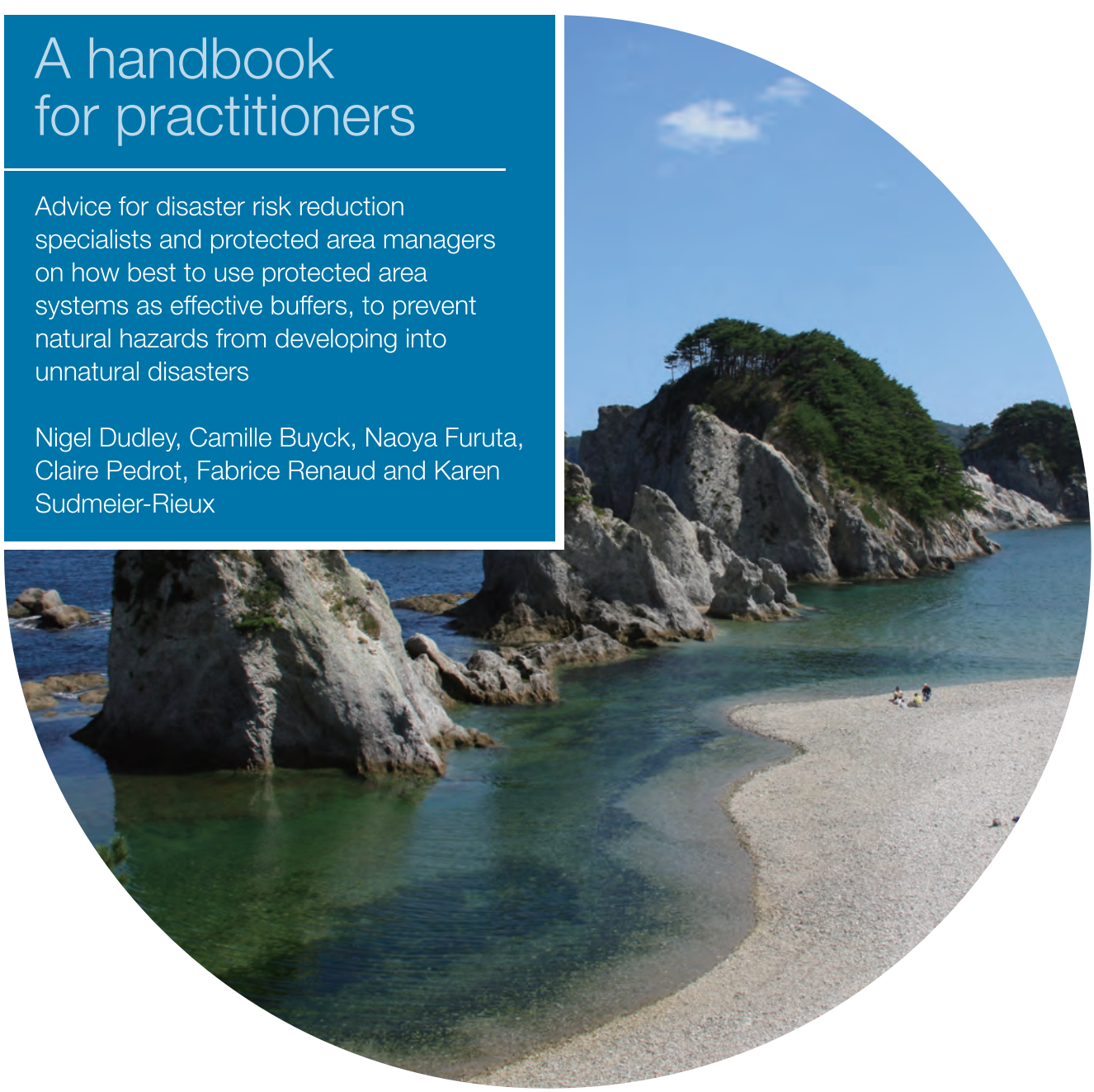
PROTECTED AREAS AS TOOLS FOR

DISASTER RISK REDUCTION

A handbook for practitioners

Advice for disaster risk reduction specialists and protected area managers on how best to use protected area systems as effective buffers, to prevent natural hazards from developing into unnatural disasters

Nigel Dudley, Camille Buyck, Naoya Furuta, Claire Pedrot, Fabrice Renaud and Karen Sudmeier-Rieux



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PREFACE

Globally, disasters due to natural hazards such as storms, flooding, drought, earthquakes and ocean surge extract an enormous toll in terms of human lives, destruction to crops and livelihoods, and economic losses. The UN International Strategy for Disaster Reduction (UNISDR) estimates that between 2000 and 2012, some 1.2 million people died as a result of disasters; 2.9 billion people were affected and disaster-related damage cost around US$1.7 trillion. Even in a world where wars seem to affect almost every continent, more people are affected by disasters than by conflict. The complicated and hard to predict implications of climate change are adding a further layer of problems facing those attempting to protect human communities against the impacts of natural hazards.

Disaster risk reduction (DRR) has therefore become a critical part of sustainable development strategies. The acronym DRR embraces a complex mixture of policies and actions, from education of civil society, through disaster preparedness strategies to engineering solutions ranging from construction of sea walls to building regulations that aim to protect cities against earthquakes.

Over the past few decades, the role of healthy ecosystems in providing cheap, reliable protection against natural hazards has been increasingly recognized. Forests and other vegetation help to stabilize slopes, prevent floods and slow or stop soil erosion and desertification. A range of coastal habitats, from corals to mangroves, protect people living near the sea from the worst of storms and tidal waves. Sustainable management policies in the drylands can halt and even reverse the spread of deserts.

But DRR strategies based on ecosystem services are failing in many places because natural ecosystems are being degraded and destroyed. In these circumstances, places that maintain functioning natural ecosystems become increasingly important. The world's protected area system, of national parks, nature reserves and wilderness areas, currently covers 15.4 per cent of land and freshwater and 3.4 per cent of coastal and marine areas[1]. Although primarily designated for their nature conservation and recreational values, protected areas are increasingly being recognized as potential tools for their role in facilitating DRR.

The following handbook provides practical guidance on the effective use of protected areas as tools to reduce the likelihood and impacts of disasters. The main text is supplemented by case studies drawing on the experience of the Ministry of Environment in Japan, the International Union for Conservation of Nature (IUCN) and partners. It is aimed in particular at:

- DRR specialists, so that they understand and can integrate protected areas into DRR strategies
- Protected area system administrators and managers, so that they recognize the value of their protected areas for DRR, and understand how best to plan and manage protected area systems to contribute to DRR strategies within protected areas and surrounding communities.

The handbook will be one of a series detailing how protected areas can maximize the ecosystem services that they provide, without undermining their fundamental nature conservation function.

AT A GLANCE: PROTECTED AREAS AND DRR

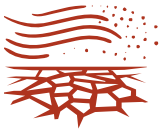
Protected areas – national parks, nature reserves and wilderness areas – can play a critical role in disaster risk reduction (DRR) strategies. They need to be factored into national and regional DRR plans. Here's why: Protected areas don't just protect wildlife. They also make sure that natural ecosystems are intact and in good health. And natural ecosystems can offer cheap, reliable and effective ways of mitigating a range of disasters:

Hurricanes and storms: forests, marshes, coral reefs, mangroves, dune systems and barrier islands all buffer coastal communities against damage from winds, flooding and storm surges.

Flooding: wetlands provide essential overflow reservoirs to reduce peak flood height and minimize impacts on people, agriculture and infrastructure. Forests and woodlands buffer and absorb flood waters, slowing the rate of flow.

Tsunamis and sea-level rise: mangroves, barrier islands, coral reefs and sand dunes all create physical barriers against ocean incursion, both slowing and blocking water movement.

Avalanches and landslides: vegetation on steep slopes provides two important benefits: roots help to bind soil together and trees slow the rate of movement of snow, rocks and soil if a slip does begin.



Drought, desertification and dust storms: protected areas can stabilize soils and reduce dust storms and desertification in arid areas by reducing grazing and trampling pressures. They can also help regeneration by maintaining drought resistant plants.

Wildfire: protected areas can help to maintain management systems that control fire patterns and exposure in savannahs, temperate and boreal forests and scrub. In tropical forests, fires are more frequent in secondary forests so preserving primary forest can help to reduce fire incidence and spread.

Earthquakes and volcanoes: forested slopes contribute to reducing earthquake-triggered shallow landslides on steep slopes. Presence of dense forest cover on volcanic slopes can also help to slow the movement of lava following eruptions.

Not all disasters can be prevented by natural ecosystems, and in any case not all natural ecosystems are in protected areas. This handbook explains what protected areas can and cannot contribute to DRR strategies. It describes how they can be integrated into national DRR strategies to the mutual advantage of both. And it looks at how to combine natural and engineering solutions in DRR. Neither alternative is perfect and both will be overwhelmed by the most severe events. It is important that planners consider both as a matter of course, and that engineering solutions do not undermine buffering properties of natural ecosystems, or vice versa, when planning for DRR.

Protected areas don't just protect wildlife. They also make sure that natural ecosystems are intact and in good health

FOR DRR PLANNERS: A RAPID INTRODUCTION TO PROTECTED AREAS

'Protected area' is a collective term for places set aside primarily to conserve nature and natural ecosystems, with major roles in safeguarding iconic landscapes, geological diversity and providing resources for recreation and tourism. In English these are known as *national parks*, *nature reserves, refuges, natural monuments*, *protected landscapes* and *wilderness areas* among other names.

The International Union for Conservation of Nature (IUCN) defines a protected area as: 'a clearly defined geographical space, recognized, dedicated and managed, through legal or other effective means, to achieve the long-term conservation of nature with associated ecosystem services and cultural values.' This stresses the primacy of nature conservation amongst its objectives and IUCN further stresses this with an associated principle: *For IUCN, only those areas where the main objective is conserving nature can be considered protected areas; this can include many areas with other goals as well, at the same level, but in the case of conflict, nature conservation will be the priority*[2]. In practice many areas will have important values alongside nature conservation (including ecosystem services such as DRR) but these should not undermine the original purpose.

Management: however, declaration of a protected area does not necessarily or usually mean that the area is set aside strictly for nature and nothing else. Protected areas are managed with a range of different strategies, from strictly protected 'no-go' areas to protected landscapes where conservation takes place alongside many other activities including settled human communities. The type of management strategy should be fit for purpose and governments increasingly select strategies in collaboration with local communities and other stakeholders. IUCN and the United Nations recognize six different broad management approaches, one of which is further subdivided:

IUCN protected area management categories

- **Ia: Strict nature reserve**: Strictly protected for biodiversity and also possibly geological/ geomorphological features, where human visitation, use and impacts are controlled and limited to ensure protection of the conservation values.
- **Ib Wilderness area**: Usually large unmodified or slightly modified areas, retaining their natural character and influence, without permanent or significant human habitation, protected and managed to preserve their natural condition.
- **II National Park**: Large natural or near-natural areas protecting large-scale ecological processes with characteristic species and ecosystems, which also supports environmentally and culturally compatible spiritual, scientific, educational, recreational and visitor opportunities.
- **III Natural monument or feature**: Areas set aside to protect a specific natural monument, which can be a landform, sea mount, marine cavern, geological feature such as a cave, or a living feature such as an ancient grove.
- **IV Habitat/species management area**: Areas to protect particular species or habitats, where management reflects this priority. Many will need regular, active interventions to meet the needs of particular species or habitats, but this is not a requirement of the category.
- **V Protected landscape or seascape**: Where the interaction of people and nature over time has produced a distinct character with significant ecological, biological, cultural and scenic value: and where safeguarding the integrity of this interaction is vital to protecting and sustaining the area and its associated nature conservation and other values.
- **VI Protected areas with sustainable use of natural resources**: Areas which conserve ecosystems, together with associated cultural values and traditional natural resource management systems. Generally large, mainly in a natural condition, with a proportion under sustainable natural resource management and where low-level non-industrial natural resource use compatible with nature conservation is seen as one of the main aims[3].

Protected areas cover more than 15 per cent of the world's land surface

Governance: protected areas also differ in how they are governed – by who makes the decisions. Although most of the world's protected area estate is in government hands, private individuals, trusts, communities and indigenous peoples all manage protected areas. IUCN recognizes a typology of governance types and any governance type can be used in any management category (see box and matrix overleaf)[4]. Protected areas can be run by anyone from a massive government bureaucracy to a group of villagers who want to preserve an area of forest near their homes. Bringing DRR into protected areas will likely increase the number of people involved in making management decisions.

IUCN protected area governance types

- **A: Governance by government**; which may mean that a federal or national ministry/agency is in charge, or a sub-national body, or sometimes that government retains control but hands day-to-day management to another body (e.g., a non-profit trust).
- **B: Shared governance**; including collaborative management, with different stakeholders having varying degrees of influence, or joint management with a pluralist management board and sharing of decisions. Transboundary protected areas, which stretch across national or federal borders, and thus imply cooperation between different countries or regions, are one important form of shared governance.
- **C: Private governance**; where protected areas are managed and often also owned by private individuals, non-profit organizations such as NGOs, universities or cooperatives, or for-profit organizations such as ecotourism companies.
- **D: Governance by indigenous peoples and local communities**; covering indigenous peoples' conserved areas and territories and also community conserved areas, declared and run by local communities.

Scale: protected areas already cover something like 15.4 per cent of land surface and a small but rapidly growing area of coastal and marine ecosystems[5]. Most have been set up in the last 50 years. Signatories to the UN Convention on Biological Diversity (CBD – this includes most countries in the world) have agreed to extend the protected area estate to at least 17 per cent of land and freshwater areas and at least 10 per cent of coastal and marine areas by 2020. The explosion of protected area designation has been a response to the rapid loss of natural ecosystems elsewhere. In many places protected areas are now the only natural ecosystems remaining. This is one reason – not the only one – why anyone interested in using natural ecosystems within DRR strategies needs to be talking with protected area agencies.

Protected areas are now found in virtually every country in the world and cover all kinds of biomes, ecosystems and geographies. They are not evenly spread: it has been easier and cheaper to protect 'rocks and ice' – mountains, deserts, ice caps and so on – than fertile and valuable lowland habitats; so for instance natural temperate grasslands are amongst the most poorly protected habitats in the world. One response to this is putting effort into developing approaches to locating protected areas in the most valuable places for conservation – systematic conservation planning, protected area gap analysis and so on. These assessments are usually done on biodiversity grounds. However, as noted above, protected areas also provide a wide range of other benefits and it is some of these that principally concern us here. But it is important to understand the basic aims of protected areas if their DRR role is to be properly understood.

The IUCN protected area matrix management category and governance type

Governance types	A. Governance by government			B. Shared governance			C. Private governance			D. Governance by indigenous peoples and local communities	
Protected area categories	Federal or national ministry or agency in charge	Sub-national ministry or agency in charge	Government-delegated management (e.g., to an NGO)	Transboundary management	Collaborative management (various forms of pluralist influence)	Joint management (pluralist management board)	Declared and run by individual land-owner	...by non-profit organizations (e.g., NGOs, universities, co-operatives)	...by for-profit organizations (e.g., individual or corporate landowners)	Indigenous peoples' conserved areas and territories – established and run by indigenous peoples	Community conserved areas – declared and run by local communities
Ia. Strict Nature Reserve											
Ib. Wilderness Area											
II. National Park											
III. Natural Monument											
IV. Habitat/ Species Management											
V. Protected Landscape/ Seascape											
VI. Managed Resource Protected Area											

FOR PROTECTED AREA PLANNERS AND MANAGERS: A RAPID INTRODUCTION TO DRR

Disasters: a disaster occurs when a natural phenomenon, like an extreme weather event, sudden earth movement or a volcanic eruption, impacts on human lives and livelihoods. A massive earthquake or a ten year drought is not a disaster if it occurs in an uninhabited desert with no-one around to get hurt. The extent to which these natural phenomena develop into disasters is partly a matter of chance as to where and when they occur; clearly a massive earthquake in a city or a drought in an agricultural area will be more serious. But the consequences of disasters is also influenced by our own actions, particularly where we choose or are forced to live, and what precautions we take to protect ourselves, including how we treat the environment around us. A 'natural disaster' may not really be so natural after all, but the result of bad management, ignorance, lack of money and unfair policies.

Rapid human population growth and inequalities of land distribution have forced many poor or politically marginalized people to settle in hazard prone areas; on flood plains, below steep slopes in places where avalanches are likely, and close to the shore where sudden ocean surges can cause devastation. These poor members of society often cannot afford to build houses strong enough to withstand earthquake shocks or typhoons. Furthermore, a lack of understanding about disasters also means that some wealthier people choose to live in areas susceptible to floods, fires and storms, often because they are in attractive locations.

When are 'natural disasters' really natural? The UN's International Strategy for Disaster reduction (2004) says:

'Strictly speaking, there is no such thing as a natural disaster, but there are natural hazards, such as cyclones and earthquakes … A disaster takes place when a community is affected by a hazard … In other words, the impact of the disaster is determined by the extent of a community's vulnerability to the hazard. This vulnerability is not natural. It is the human dimension of disasters, 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' [6].

At the same time, in countries where extreme weather events and earth movements can occur everywhere, there is no easy escape. Major earthquakes have caused devastation in San Francisco in California, Christchurch in New Zealand and Tokyo in Japan for instance, killing wealthy people in sturdy buildings.

But people living in poorer countries tend to suffer more damage and higher death rates than those in richer countries, because buildings tend not to be as robust, people are more likely to be living in areas exposed to natural hazards, there will be less effective emergency services and environmental degradation is often more severe.

Disaster risk reduction: The UN International Strategy for Disaster Reduction (UNISDR) defines DRR as follows: '*Disaster Risk Reduction aims to reduce the damage caused by natural hazards like earthquakes, floods, droughts and cyclones, through an* ***ethic of prevention*** *[our emphasis]... Disaster risk reduction is the concept and practice of reducing disaster risks through systematic efforts to analyse and reduce the causal factors of disasters. Reducing exposure to hazards, lessening vulnerability of people and property, wise management of land and the environment, and improving preparedness and early warning for adverse events are all examples of disaster risk reduction*'[7].

In other words, DRR doesn't focus on reducing the likelihood of natural hazards occurring, which is usually impossible, but on designing societies, environments, livelihoods and lifestyles that are best able to withstand these hazards when they come along.

The link with ecosystem loss: one consequence of badly planned and unsustainable development is that natural ecosystems tend to be degraded or destroyed in the process. This is what concerns us here. Loss of forests, mangroves, flood plains, coastal wetlands and coral reefs remove the buffering systems that otherwise help mitigate disasters. In consequence environmental degradation leaves human communities more vulnerable to disasters.

The Millennium Ecosystem Assessment notes that: '*Changes to ecosystems have contributed to a significant rise in the number of floods and major wild fires on all continents since the 1940s*'[8]. This was seen dramatically in one of the richest countries in the world, back in 2004, when Hurricane Katrina hit the coast at New Orleans in the United States. Losses of coastal forests and wetlands left communities exposed and many people died or lost their homes and possessions. As is often the case, the poorest communities living in the least desirable neighbourhoods were the worst hit.

The link with climate change: many of the natural hazards that can develop into disasters may be affected by climate change. Extreme weather events such as typhoons, hurricanes, torrential rain and drought are becoming more difficult to predict. Rising sea levels will bring human communities closer to the impacts of coastal storms. We are creating an increasingly disaster prone planet.

What the Intergovernmental panel on Climate Change says

'More severe and/or frequent extreme weather events and/or hazard types are projected to increase losses and loss variability in various regions and challenge insurance systems to offer affordable coverage while raising more risk-based capital, particularly in developing countries' [9].

And disasters are apparently increasing, despite better disaster preparedness mechanisms, increasing amounts of money being spent on disaster reduction, better technology, communications and weather prediction systems. Economic losses from weather and floods have increased dramatically in the last half century and disasters also carry a heavy toll in terms of people killed, injured, impoverished and displaced. In 2012 for example, 32 million people around the world were displaced by disasters, more than were displaced by armed conflict[10].

The role of environmental management in disaster risk reduction: there is increasing recognition that natural ecosystems, in the right place and under the right management regime, can help to avert and reduce the impacts of disasters. However, despite many positive examples at the scale of individual cities and communities, management of natural areas still only plays a small role in most national disaster risk reduction strategies or in international efforts at disaster reduction.

What the United Nations says

In 2004, the **UNISDR** noted that *'Although the inherent links between disaster reduction and environmental management are recognized, little research and policy work has been undertaken on the subject. The intriguing concept of using environmental tools for disaster reduction has not yet been widely applied by many practitioners'*[11]. A year later, the **World Conference on Disaster Reduction** urged governments to take a greater interest in *'the environmental aspects of disasters, and particularly in the critical roles in disaster reduction of managing and maintaining environmental systems to reduce the impact of disasters'* [12].

In 2014, a report for the **United Nations Environment Programme** and the UN **Office for the Coordination of Humanitarian Affairs** argued that: *'a fundamental shift towards a model of humanitarian action that not only strengthens the response to crisis, but also learns and adapts in order to anticipate crises, act before they become disasters and prevent their recurrence. Better attention to environmental stewardship, with its multiple and inextricable linkages with human livelihoods, is central to this'* [13].

Yet we are still not addressing this comprehensively. The role of environmental management still barely features in many DRR responses and the potential of protected areas has been almost entirely unrecognized in DRR strategies (although this is starting to change). Similarly, DRR is usually absent from protected area management plans.

Protected areas have opportunities to contribute directly to DRR and also to provide lessons that can be applied more generally throughout the landscape. The extent to which a protected area can contribute to DRR depends on its location, size, and the ecosystems under protection. Protected areas are likely in most cases to be elements within a larger DRR strategy, which provides valuable opportunities for mainstreaming protected areas. Understanding their potential role is a critical first stage in this process.

Disaster Risk Reduction aims to reduce the damage caused by natural hazards like earthquakes, floods, droughts and cyclones, through an ethic of prevention

UN International Strategy for Disaster Reduction

TOOL 1: QUICK GUIDE – HOW NATURAL ECOSYSTEMS HELP DISASTER RISK REDUCTION

Natural hazard	Buffering from ecosystems in protected areas
Cyclones, typhoons & hurricanes	• Coastal ecosystems (barrier islands, coral reefs and atolls, mangroves, coastal forests, sand dunes) buffer communities against storm damage • Coastal marshes attenuate storm surges associated with cyclones, hurricanes and typhoons before they reach onshore settlements • Forests help to buffer inland areas, and reduce the risks of subsequent land slippage following storms
Flooding	• Maintaining natural wetlands and flood plains provides space for floodwater to be stored without causing harm • Riparian woodland and other forest cover helps to buffer flood water, slow the flow and absorb excess water
Tsunamis	• Coastal ecosystems (islands, coral reefs and atolls, mangroves, coastal forests, sand dunes) provide a barrier or series of barriers that can reduce the distance and speed with which a tidal wave travels inland
Sea-level rise	• Coastal ecosystems (mangroves, coastal forests, sand dunes) can help to slow the impact of sea-level rise. They need careful management (including inshore restoration) if they are not to degrade over time
Avalanches & landslides	• Vegetation on steep slopes protects valley communities by stabilising soil, anchoring snow and providing a physical barrier to earth and snow movements that do occur
Droughts	• Forest protected areas can provide sources of wild food and animal fodder during periods of drought if sustainably managed • Natural vegetation and drought resistant plants can provide sustainable grazing in protected landscapes
Desertification & dust storms	• Healthy desert vegetation reduces rates of wind and flood related soil erosion, thus greatly reducing dust storms (and associated respiratory diseases) and desertification
Wildfire	• Primary forest in moist tropical forest areas is far less susceptible to wildfire than degraded secondary forests • Presence of protected area managers and rangers provides expert advice on managing fires in a range of ecosystems (including prescribed fires to reduce risk of wildfire)
Earthquakes	• Many problems from earthquakes arise from subsequent earth movements, including shallow landslides. In mountainous areas forested catchments suffer less after-effects from earthquakes than occurs under bare slopes
Volcanoes	• Forests can slow the rate of lava flow when volcanoes erupt • Valleys and watercourses can channelize and contain lava flow

FOR DRR PLANNERS AND PROTECTED AREA MANAGERS: WHY PROTECTED AREAS IN PARTICULAR?

Natural ecosystems under many management regimes can and do help mitigate disasters and should be included in DRR strategies. But protected areas offer four additional advantages:

1. **They are very effective ways of maintaining natural ecosystems**. Research shows that protected areas generally and markedly reduce the rate of vegetation loss compared with other management regimes[14]. In many areas they are the only substantial areas of natural vegetation remaining.
2. **Policies and legal structures are already in place**. Government managed protected areas already exist within legal and policy frameworks at both international and national level, which aim to sustain the very values that are important for DRR. In the case of protected areas run by NGOs, private trusts, indigenous peoples and communities, this framework is provided variously by charity status agreements, company statutes, traditional practices or common law.
3. **Management plans already exist to provide a framework for action**. Good protected areas already have multi-year management plans in place, which should include risk analysis and disaster planning, along with an associated process for review and renewal. These plans can be modified to recognize more explicitly the importance of integrating DRR strategies into place.
4. **Trained managers and rangers are present to implement DRR policies**. Most protected areas have

TOOL 2: QUICK GUIDE – WHAT YOUR PROTECTED AREA MAY HAVE TO OFFER TO DRR STRATEGIES

Element	What it provides
Forests	• Protection against extreme weather events and sudden water, earth and lava movements • Storage and sequestration of carbon to mitigate climate change • Emergency supplies of human food and livestock fodder in times of drought and famine • Medicine supplies during times of disaster and epidemic
▶ ***Forests on steep slopes***	• Protection against avalanches, particularly during the snow melt • Protection against landslides and rock fall, particularly following storms or sudden earth movements • Slowing rate of flood waters • Slope stabilization
▶ ***Forests beside rivers & streams***	• Slowing and buffering discharge rates in floods • Bank stabilization against erosion
▶ ***Coastal forests and mangroves***	• Buffering against ocean surges as a result of typhoons, hurricanes or tsunamis • Islands of safety during coastal inundation • Longer term protection against sea-level rise if managed correctly (including restoration inland as necessary)
▶ ***Tropical rainforests***	• Reducing risk and rate of spread of wildfire • Major role in storing and sequestering carbon to mitigate climate change • Source of water during drought • Increased infiltration capacity
Grassland	• Stabilising soil in arid areas • Storage and sequestration of carbon to mitigate climate change
Dryland vegetation	• Stabilising soil in arid areas • Protection of drought resistant plants for emergency grazing • Regulating fire regimes
Wetlands & wild rivers	• Providing spillage and storage areas during flooding
Coastal wetland	• Providing an area for absorbing and storing sudden ocean surge as a result of typhoons, hurricanes and tsunamis • Storing and sequestering carbon against climate change
Coral reefs	• Buffering against ocean surge as a result of typhoons, hurricanes and tsunamis
Barrier islands & sand dunes	• Buffering against ocean surge and other inundation as a result of typhoons, hurricanes and tsunamis
Sea grass beds & kelp beds	• Storing and sequestering carbon to mitigate against climate change

managers, rangers and other staff and volunteers. These people have skills and logistical abilities to manage ecosystems and are suitable for in-job extension training if needed to focus on DRR-specific aspects of management. Good protected areas should already be run by, working with, collaborating with and taking advice from local communities and other stakeholders. This will help to facilitate any negotiations relating to putting DRR policies in place; indeed recognition that a protected area has a role in preventing disasters is often a way of increasing local support for its existence. In some places protected area staff are amongst the only trained professionals in remote regions, with the best capacity and equipment, and thus by default take on wider extension roles, which can be expanded to include DRR.

Recognition that protected areas are about more than just looking after biodiversity is a critical step. A good capacity building programme is a key part of this process. If a protected area is playing a recognized role in DRR it is important, from the perspectives of protected area management and DRR, that everyone from government to local communities are aware of this. Explanatory signs, open days, programmes on local radio and presentations in village meetings are all important.

Protected areas offer a unique set of tools for managing DRR

FOR TREASURY OFFICIALS AND FINANCE OFFICERS – WHY PROTECTED AREAS?

Protected areas are often regarded as a frustrating drain on the economy by many government departments and by the Treasury. If they are used for DRR as well, many of these costs will appear more justifiable.

1. Protected areas are a valuable and effective tool for helping to address many of the conditions that cause natural hazards such as extreme weather events and major earth movements to develop into disasters.
2. In some cases, designating or managing protected areas can be a cheaper option than alternative DRR strategies such as major engineering works. They come with an existing management structure, boundaries, management infrastructure and in a growing number of cases will also have effective monitoring systems in place, making it relatively easier to track investments in DRR-related management. Hybrid solutions involving engineering and ecosystem management are often necessary.
3. And in virtually all cases, DRR from protected areas will be additional to other multiple benefits that protected areas bring to (mainly) rural communities, such as from tourism, jobs and other ecosystem services.
4. The government will already be investing in establishment and management of state protected areas for biodiversity conservation, recreation and tourism. Additional incorporation within DRR strategies means that such state investment produces a wider range of benefits, which address the needs of more government departments, and is thus a more efficient use of tax revenue.
5. It should also be remembered that well located and managed protected areas also bring important benefits that are hard to quantify in economic terms, including wellbeing benefits for local communities and the political returns from meeting commitments to international agreements such as those of the CBD.
6. Incorporating DRR into protected area management does not always involve additional costs. But in some cases there will certainly be additional costs; for instance if new protected areas are designated partly because of their DRR function, or if management changes and restoration programmes are needed within existing protected areas. (For example, restoration of mangroves or sand dune systems in coastal protected areas to provide improved buffering against storms and ocean surges.) Relevant costs and benefits therefore will need to be compared with alternatives and evaluated. However, the positive relationship between DRR benefits and healthy natural ecosystems means that investment in restoration can simultaneously improve both DRR and conservation outcomes.
7. Treasury officials and financial experts can help in making these decisions. Such decisions are part of a wider framework of efforts to streamline and improve the efficiency of protected area management and address disaster risks. Further, those with expertise in financial management can also offer assistance to protected area managers who are looking for ways to improve cost effectiveness, such as through the introduction of Payment for Ecosystem Service (PES) schemes and similar.

Using protected areas to mitigate disasters can be a low cost option using resources that are already receiving government funds

ANALYSIS AND SCENARIO-BUILDING

There are a range of tools available to help make decisions about particular DRR strategies, including various assessment systems, risk analysis and scenario-building. When two or more options are available for addressing a particular DRR situation, a common occurrence, it is best to start by examining the advantages and disadvantages of each as clearly as possible, ideally in collaboration with a range of other relevant stakeholders. A variation on a SWOT (Strengths, Weaknesses, Opportunities and Threats) analysis framework may be suitable, as outlined in Tool 3 overleaf.

Doing a SWOT analysis or similar assessment doesn't usually give a single definitive answer; DRR planners will still need to make a judgement call. But it does encourage everyone to think through things logically and not to miss out important issues and opportunities.

Comparisons can be taken a step further by use of scenario planning – developing and outlining a range of logical sequences of events under different DRR strategies and testing which of these is the most acceptable. Scenario planning is more complicated than just analysing different options and implies involvement of many people and probably also assistance by a facilitator who understands and can lead people through the process. There are many different models of scenario planning: one relatively simple process is laid out overleaf:

TOOL 3: MATRIX FOR COMPARING DIFFERENT DRR STRATEGIES

Strategy	Strengths for DRR	Weaknesses for DRR	Costs – financial	Costs – social, environmental	Additional benefits	Risks

So for example a comparison between various different ways of addressing risks of ocean surge might be as follows:

Strategy	Strengths for DRR	Weaknesses for DRR	Costs – financial	Costs – social, environmental	Additional benefits	Risks
Establish protected area for mangrove conservation	Proven effective at reducing sea surge	Will be overwhelmed by strongest seas. Liable to loss from illegal felling	Relatively low, some restoration, guarding against illegal use	Locking mangroves into a protected area reduces options for fuelwood etc	Mangroves boost fish stocks by providing spawning and breeding sites	That mangroves do not provide adequate protection
Construction of sea wall	Proven effective at reducing sea surge	Can be overwhelmed	Relatively high; major infrastructure project and continued maintenance	Aesthetic impacts. Risks that if sea wall is built in front of mangroves, they will decline and die	No additional benefits	Sea wall provides false sense of security, structural weaknesses appear over time
Relocate coastal community from high risk areas	Eliminates most of the need to protect against sea surge	Does not actually address the underlying problem – still risks if people are present	Likely very high; relocation and compensation costs	High social costs, likely to be strong resistance. Potential environmental costs in relocation sites	Possible conservation benefits in sites that have been abandoned	Not everyone will move. People will continue to use high risk areas even if living elsewhere

1. **Decide drivers for change/assumptions**: identify the different factors that are going to impact on choices about DRR (e.g., weather patterns, location of settlements, risks of extreme hazards, implications of projected climate change etc.).
2. **Bring drivers together into a viable framework**: work out how the various drivers identified above link to each other.
3. **Produce a set of initial mini-scenarios**: briefly sketch out a wide range of different possible 'plot-lines' for how DRR strategies might be used to address the drivers of risk.
4. **Reduce to 2-3 scenarios**: abandon any scenarios that are either implausible or contain major disadvantages, and focus down on the few that are really worthy of consideration.
5. **Draft the scenarios**: write a brief description of each of the most attractive DRR scenarios in clear and accessible language.
6. **Identify the issues arising**: examine these scenarios and discuss implications in detail, to help determine which one will finally be chosen.

At one level scenario planning is just talking through the options, but doing this in a logical, transparent way that attempts to avoid subjectivity and missing out important elements.

Natural barriers like sand dunes and mangroves help to block the impact of major storm events

DISASTER BY DISASTER – A GUIDE TO HOW PROTECTED AREAS CAN HELP

The following sections look at a range of natural hazards that often develop into disasters and explain:

- What can protected areas do to help?
- What can't they do?
- Can protecting natural ecosystems ever make things worse rather than better?
- What does this mean for protected area planners?
- What does this mean for protected area managers?
- What does it mean for DRR specialists?

CYCLONES, TYPHOONS AND HURRICANES

When cyclones develop sustained winds of 119 km per hour they become known as hurricanes in the Atlantic and northeast Pacific and typhoons in the western Pacific; the most powerful storms on the planet[15]. As cyclones often build in the deep ocean, coastal areas are particularly at risk, being the first land areas that the storms hit. The process of forecasting, protecting against and reacting to these events is big business. Storms can affect any region. Human development factors and demographic changes are increasing vulnerability to storms.

What can protected areas do to help?

- Coastal ecosystems (barrier islands, coral reefs and atolls, mangroves, coastal forests, coastal marshland and sand dunes) provide buffering against immediate storm damage and associated storm surge
- Coastal marshes mitigate storm surges associated with cyclones, hurricanes and typhoons before they reach onshore settlements
- Forests help to buffer inland areas, and reduce the risks of subsequent land slippage following storms
- Protected areas can be used to improve the reliability of engineered structures to deliver protection against major disasters

What can't they do?

Like any barrier, there is a limit to how much protection can be provided (for example as a function of barrier height) and force that can be absorbed (being important to the size and strength of areas of vegetation, sand, coral etc.) in the case of the most severe storm events.

Can protecting natural ecosystems ever make things worse rather than better?

If storm damage is so severe that it rips off branches and uproots trees the barriers themselves can become damaging projectiles; this possibility should for instance influence the location of buildings in and around protected areas and other natural forests and planted trees.

What does this mean for protected area planners?

Management and where necessary restoration of buffering habitats in storm-prone areas is a long-term contribution to DRR planning. For example loss of dunes and mangroves in many parts of the world is already seriously contributing to the impacts of storms. Loss of coastal wetlands in Louisiana was identified as a major reason why Hurricane Katrina devastated New Orleans in 2005. This and other similar disaster impacts occurred through poorly controlled development (often tourism-related) of coastal areas. The use of protected areas as a tool to secure coastal buffers needs to be factored into land-use planning at a national or even transnational scale.

What does this mean for protected area managers?

The key management implications include careful management and restoration of buffering ecosystems: particularly mangroves and coastal forests (ensuring use of native species), coral reefs, coastal marshes and sand dune complexes. Restoration can in many places be undertaken in cooperation with local communities (indeed it may simply be a case of agreeing restrictions on resource extraction with these communities) thus reducing time and costs. Zoning may need to be revised to ensure that protected areas best address risks to local communities.

What does it mean for DRR specialists?

DRR planning needs to factor in the presence and more importantly absence of natural buffers into response strategies. Communities that are unprotected need help to address these risks. DRR planners must often work in cooperation with judiciary and enforcement agencies to address the unplanned and illegal removal of natural barriers, for example by the tourism industry. They also need to address less obvious and immediate effects on the sustainability of land-use patterns, such as those associated with sea-level rise.

What the Intergovernmental Panel on Climate Change says

'...The future influence of climate change on tropical cyclones is likely to vary by region, but the specific characteristics of the changes are not yet well quantified and there is low confidence in region-specific projections of frequency and intensity'[16]

Best practice for using protected areas as buffers against typhoons and hurricanes

- Maintain natural barriers (forests, mangroves, coral reefs, coastal marshes, barrier islands and sand dunes) in storm-prone areas, particularly along coasts where human communities have been established.
- Where necessary restore natural barriers that have disappeared, by active planting or seeding, active restoration of land barriers and / or through removal of pressures.
- Introduce protected area zoning that incorporates DRR elements.

For examples, see case studies on Thailand and Indian mangroves on page 15 and 16.

CASE STUDY

PROTECTING COASTS FROM TYPHOONS AND TSUNAMIS WITH MANGROVE: KRABI RIVER ESTUARY, THAILAND

In Thailand's Krabi River Estuary, the Community-Based Ecological Mangrove Restoration (CBEMR) methodology developed by the Mangrove Action Project (MAP), a local NGO, is being used to restore mangrove and wetlands ecosystems as natural infrastructures to help protect people against coastal hazards.

The Krabi River Estuary was listed as a Ramsar Site in 2001. Its 100 km² of mangrove forests and 12 km² of tidal mudflats, together with the exceptional biodiversity that they host, make it a popular area for tourists and birdwatchers. The local economy is largely based on the sea, with the majority of people being boatmen or small-scale fishers catching fish, prawn, crabs and shellfish.

In this region, as in the rest of Asia, large areas of mangroves have been cleared for aquaculture, particularly shrimp production, which has often left coastal communities exposed to tropical storms, storm surges and salinization of soils and fresh water supplies. Shrimp aquaculture is very much a boom and bust industry which has resulted in large areas of abandoned shrimp ponds in the former mangrove inter-coastal zone which are now unproductive. These areas have the potential to be returned to functioning productive ecosystems that act as bio-shields, while providing important goods and services on which local communities rely for livelihood, as well as for the growing tourism industry.

The Ecosystems Protecting Infrastructure and Communities (EPIC) project seeks to demonstrate the contribution of healthy mangrove forests to protect vulnerable coastal communities against tropical storms, as well as mitigating the effects of sea-level rise. The CBEMR method is being implemented in an abandoned shrimp pond in Klong Kam village, to restore part of the protected area's coastline into a biodiverse and resilient mangrove ecosystem. Restoring mangroves on the coastline of the Krabi Ramsar Site offers a flexible, cost-effective and sustainable first line of defence from extreme climatic events. Indeed, this will bring valuable economic co-benefits, as the net economic value of mangrove forests in the Krabi River Estuary for coastline protection and stabilisation was estimated at US$ 390,609 per year and their net value for carbon sequestration at US$ 22,466 per year[17].

As the frequency and magnitude of natural disasters increase, protection from such events grows in significance. The protective function of mangroves in the Krabi River Estuary represents a form of climate change adaptation, as well as DRR. While mangroves are likely to be affected by climatic adjustments, their restoration and conservation could offer multiple benefits for communities in terms of mitigating and adapting to climate change[18].

Further information: EPIC website: www.iucn.org/epic and MAP website: www.mangroveactionproject.org

CASE STUDY

COMPARING RICE CROPLAND PRODUCTIVITY WITH OR WITHOUT MANGROVES PROTECTION AFTER A CYCLONE

Following an intense cyclone which hit the region of Odisha, East India, in 1999, scientists studied the role of mangrove forests within a protected area in supporting livelihoods, comparing rice crop productivity in croplands with or without protection provided by mangroves.

The study took place in the Bhitarkanika Conservation Area (BCA) which includes the Bhitarkanika National Park, the Bhitarkanika Wildlife Sanctuary and the Gahirmatha Marine Sanctuary and protects 145 km² of mangroves. In this region, rice cropping is crucial for food security because it represents the main livelihood activity, and mangroves have often been deforested to allow rice cropping expansion. Moreover natural disasters such as tropical cyclones frequently hit the area, leading to Odisha's coast being identified as one of the world's disaster-poverty hotspots. Beside killing people, cyclones strongly impact rice crops, with consequences on food security and economic growth. The overall objective of the study summarized here was therefore to compare the impact of cyclones on rice croplands in areas without and with protection provided by Bhitarkanika's mangroves (at extensive density and low-density).

Using remote sensing data and a Geographical Information System (GIS), scientists showed that where the mangrove buffer was extensive, rice croplands were more resistant and had a greater capacity to resist cyclone impacts. Results also indicate that where mangrove buffers where in place, croplands' productivity recovered at a quicker rate compared to croplands without a mangrove buffer.

In a region often hit by natural hazards, Bhitarkanika's mangrove forests have a key role to play for providing sustainable livelihoods. Mangroves can reduce the impact of cyclones and increase the resilience of both croplands and people. Their presence (or their restoration) is essential for longer term livelihoods, environmental conservation and economic growth.

Source: Duncan, J., Dash, J., and E. Tompkins. 2014. 'Chapter 6: Mangrove forests enhance rice cropland resilience to tropical cyclones: evidence from the Bhitarkanika Conservation Area' in Murti, R. and C. Buyck. (Eds.). *Safe havens: Protected Areas for Disaster Risk Reduction and Climate Change Adaptation*. IUCN, Gland, Switzerland.

FLOODING

Flood-related disasters are increasing around the world[19]. This is partly because space limitations (or misunderstanding about the likelihood of flooding) mean that more people are living in flood prone areas. Climate change is also aggravating the causes of flooding in some places. Some engineering efforts to stop local flooding, especially straightening and banking up rivers (channelization), have removed natural dispersal points such as floodplains and thus pushed problems further downstream. One community's solution becomes another community's problem. Finally, replacing soil with concrete in towns and cities means that water keeps flowing rather than being absorbed into the ground, increasing the risk of rapid flash flooding. We are creating a world that is more prone to flooding, and less able to cope with floods when they occur [20].

What can protected areas do to help?

Natural or semi-natural habitats can mitigate flooding by:

- Providing space for floodwaters to flow without causing major damage – wetlands and floodplains provide natural insurance against flood damage. Protected areas keep these places intact.
- Absorbing the impacts of floods through the uptake of water by natural vegetation[21].

What can't they do?

Natural vegetation won't stop the worst floods (nor will engineered barriers come to that) and there is a limit to what floodplains can absorb and store. Most experts recommend a mixture of both natural and engineering approaches to flood control. Effectiveness of natural ecosystems also depends on the scale being considered; forests may be effective on a catchment scale but be less effective at the scale of large river basins.

Can protecting natural ecosystems ever make things worse rather than better?

Not usually; protecting floodplains, wetlands and riparian forests is a least risk insurance policy that brings additional benefits as well. However, if engineered solutions are abandoned in favour of relying solely on wetlands for protection, some people might have to be relocated or face increased flood risks.

What does this mean for protected area planners?

Potential flood mitigation benefits should be taken into account when designing protected area systems. It is important to ensure that wetlands are still connected to water courses so that excess flood waters can use wetlands to disperse. Restoration of riparian vegetation in existing protected areas should be considered (particularly for managed areas within IUCN category V protected landscapes).

What the United Nations says

The **UNISDR** *Guidelines for Reducing Flood Losses*, note that '*Zoning of flood-prone lands as ecological reserves or protected wetlands can often help to meet broader environmental or biodiversity goals... such lands often play an important role in sustaining the fishery, and they can also act as temporary storage and infiltration areas... It is better to have the land zoned and used for purposes such as parks, nature areas or ecological reserves than to try and ensure that future development is flood proofed... The land along a river is highly desirable for parks and recreational uses, as well as for ecological reserves'*[22].

The **United Nations Environment Programme** recognizes five types of floods:

- **Flash floods**: following heavy, intense rainfall in a relatively small area, commonest in arid, hills and steep areas and in towns and cities.
- **River floods**: following prolonged heavy seasonal rain, melting snow or a combination of both, when water flow surpasses the capacities of natural or artificial banks of a river or when dams or dykes break.
- **Coastal and estuarine floods**: caused as a result of sea-level rise beyond normal levels usually due to ocean storm surges and tsunamis.
- **Glacial lake outburst**: leading to floods in and downstream of high mountainous glacial environments; an increase has been attributed to global warming.
- **Ponding**: when water accumulates in closed depressions as a result of soil saturation or impermeability, typically on manmade surfaces or soils with slow percolation rates.

What does this mean for protected area managers?

Managers need to understand flood dynamics and what is likely to happen in the case of regular flooding or (particularly) irregular, rare and massive flooding events and how management might help mitigate both regular flooding and occasional high-magnitude floods. This should include liaison with local water authorities and disaster risk professionals. Targeted management actions may be justified, such as restoration of natural river flow, wetland areas and forests. This may also provide refuge areas for wildlife if larger areas are managed for flooding.

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What does this mean for DRR specialists?
Key activities include understanding what protected areas in the region might have to offer, which additional areas might need protection, and adoption of a whole watershed approach to water security and liaising with both the protected area authority and protected area managers.

‘Zoning of flood-prone lands as ecological reserves or protected wetlands can often help to meet broader environmental or biodiversity goals...’

UN International Strategy for Disaster Reduction

Best practice for protected areas and flood prevention

- Design protected area systems to include a range of natural floodplains and wetlands that can absorb and store flood water, and include natural forests on steep slopes and next to watercourses, to provide maximum buffering potential.
- Ensure that vegetation is in good health and resilient to natural flood patterns, including through restoration policies if necessary.
- Build good working relations between DRR specialists, protected area authorities and water authorities to ensure that everyone understands what they can contribute to flood prevention strategies. This can be achieved through development of collaborative working groups and representation of protected areas on regional disaster planning committees.
- Include integrated water management elements and watershed approaches into protected area planning to connect protected areas better to the surrounding hydrological system.

For an example, see case study of Spain on page 19.

CASE STUDY

CONTROLLING FLOODS BY USING NATURAL WETLANDS AS OVERSPILL: THE CASE OF THE COASTAL LAGOON OF A FROUXEIRA IN SPAIN

© Fra Paleo

In the A Frouxeira protected area, in Spain, environmental restoration has managed components of the coastal lagoon, reducing risks of periodic flooding for the neighbouring communities.

The coastal lagoon of A Frouxeira was declared as a Ramsar Convention wetland in 1993 and a European Site of Community Importance in 2004. The lagoon, which is some 1,700 metres long and up to 500 metres wide, has annually fluctuating water levels caused by the natural intermittent seasonal opening of a canal through the dune system at the seashore, and a horizontal variation in salinity. Thus, the lagoon moves from a state of low water with saltwater intrusion and a state of high water occasionally causing flooding in the surrounding natural and built-up areas. Continued human disturbances over the whole wetland system has modified ecological processes and reduced the quality of the ecosystem services provided by the protected area. This, combined with suburban encroachment, has increased the vulnerability of people to flooding hazards.

In order to respond to seasonal floods on the shore of the lagoon, various actions have been taken to mitigate impacts caused by past human disturbances, in particular small-scale sand mining and a canal opened in the central part of the dune system. The latter was closed as part of a restoration process, which helped to stabilize the processes of erosion and sand deposition in the northern area of the lagoon and favoured the return to intermittent circulation through the long-established and natural eastern canal. Visitor infrastructures on the beach were demolished and the dunes were restored using native species of vegetation. This managed retreat of the built area followed by environmental restoration led to a reduction in human vulnerability to windstorms and coastal flooding.

Although the damage caused by human interventions has been partially corrected, no integrated action has been planned or implemented thus far for an effective management of both the protected area and DRR. As a consequence, other development actions are in conflict with the goals of ecological restoration and are increasing vulnerability. Continued floods in certain locations are a symptom of more general ecological instability and a factor for social disruption. Weak governance has led to an increase in social complexity and conflict, with some of the stakeholders taking irreconcilable positions leading to a range of controversies. While the restoration of the central section of the dune system has been effective with evident positive effect, a more integrated governance of the lagoon of A Frouxeira, including all relevant governing bodies and stakeholders, is necessary so as to effectively manage disaster risk in the area.

Source: Fra Paleo, U. 2014. 'Chapter 13: Human perturbation and environmental governance of the coastal lagoon of A Frouxeira, Spain, for seasonal flood mitigation of suburban dwellings' in Murti, R. and C. Buyck. (Eds.). *Safe havens: Protected Areas for Disaster Risk Reduction and Climate Change Adaptation*. IUCN, Gland, Switzerland.

TSUNAMIS

A tsunami occurs when an earthquake or volcanic eruption on the ocean bed creates a giant wave, or usually a series of waves, that travel swiftly across the ocean surface until they either dissipate or are blocked by land. Huge tsunamis in Asia in 2004 and 2011 have raised international awareness of this hazard, although smaller and more localised tsunamis happen more frequently. Giant tsunamis are probably the single largest cause of death from disasters; the 2004 waves that hit Sri Lanka, Thailand, Indonesia and surrounding countries killed over a quarter of a million people in a few moments.[23] Indications of an approaching tsunami (for instance the sea often retreats from shore an unnaturally long way as the wave approaches) only give people a few minutes to respond.

What can protected areas do to help?

As in the case of severe storms, coastal ecosystems (barrier islands, coral reefs and atolls, mangroves, coastal forests and sand dunes) provide a barrier or series of barriers that can reduce the distance that the wave travels inland. Additionally, ecosystems such as sand dunes which may be overtopped by initial waves may continue to reduce the impacts of subsequent waves by helping dissipate wave energy.

What can't they do?

There is a huge debate about the extent to which mangroves and coral reefs slow tsunamis and the results are likely affected by very local differences in condition. It is clear in recent tsunamis that in some situations natural vegetation dramatically reduced the height and reach of the waves, while in others the waves were so severe that they overwhelmed all defences.

Can protecting natural ecosystems ever make things worse rather than better?

This is usually a robust risk reduction option. Exceptions are when the tsunami wave uproots mangroves or coastal forests and these themselves become hazards while washed inshore. Evidence suggests that this can happen, although in many cases trees can bend with the water and survive where buildings and other artificial infrastructure are washed away.

What does this mean for protected area planners?

Management and where necessary restoration of buffering habitats in storm-prone areas, including coral reefs, barrier islands, sand dunes, mangroves and coastal forests, is a long-term contribution to DRR planning. Natural barriers are particularly important where coastal topography means that the wave is likely to be funnelled and become even higher.

What does this mean for protected area managers?

The key management implications are for careful management and restoration of buffering ecosystems, in cooperation with communities likely to be affected by any tsunami.

What does it mean for DRR specialists?

There are two critical lessons for DRR specialists:

- The importance of incorporating natural defences into DRR strategies, which means supporting creation and management of protected areas where these supply protection and opposing the (often illegal or semi-legal) conversion of coastal habitat to incompatible land-uses.
- Ensuring that where engineering solutions are incorporated into planning that they do not inadvertently undermine natural solutions; for example it makes more sense to build a sea wall inland of a mangrove forest so that there are two barriers, rather than on the seaward side, thus probably killing the mangroves and halving the defence opportunities.

A current area of DRR work involves investigations into the benefits of combining protected areas and engineered approaches. This approach has significant potential benefits for the resilience of engineered structures for DRR in addition to providing for other values.

Best practice for using protected areas as buffers against tsunamis

- Maintain natural barriers (forests, mangroves, coral reefs, barrier islands and sand dunes) in tsunami-prone areas, particularly along coasts where human communities have been established and where coastal geography is likely to increase the height and speed of the approaching wave.
- Where necessary restore natural barriers that have disappeared, either by active planting or seeding, and / or through removal of pressures.
- Practice integrated planning for DRR; avoid placing engineered barriers in sites where they undermine the effectiveness or existence of natural barriers.

For an example, see case study of Japan on page 21.

CASE STUDY

DISASTER RISK REDUCTION BY COMBINATION OF DISASTER PREVENTION FUNCTION OF FORESTS AND DISASTER PREVENTION FACILITIES AND UTILIZATION OF ECOSYSTEM SERVICES: KESENNUMA OHSHIMA ISLAND, MIYAGI PREFECTURE, JAPAN

© Kesennuma Oshima, Japan/ Ministry of the Environment Japan

Kesennuma Ohshima Island, located in *Kesennuma* City, Miyagi Prefecture, Japan, occupies a part of Sanriku Fukko (reconstruction) national park. Nature experience opportunities provided by the island, such as nature trailing, sea bathing, and fishing, used to attract many tourists before the Great East Japan Earthquake in 2011. The island, an important sightseeing spot for the local community, was hit by the earthquake-triggered tsunami of about 12 metres in height. As a result, the islanders suffered serious damage including loss of lives of approximately 30 people, 1per cent of the island's population.

After the 2011 earthquake, *Miyagi* Prefecture decided to develop disaster prevention plans for *Tanakahama* beach and *Kodanohama* beach in *Kesennuma Ohshima Island* with the aim of prioritizing the safety of community members and realizing life in harmony with the natural environment, based on consultations with local community members.

Based on the plan developed for *Tanakahama*, a seawall of T.P. +3.9 metres high will be reconstructed on the beach near the shoreline as it was before the earthquake. The local administrative authority will buy the affected land for agriculture, among others, behind the seawall to establish disaster prevention forests. These forests will be T.P. +11.8 metres with a mounded forest floor, which provides protection against tsunamis that occur rather frequently. The terrain, the height of inland area is higher than that of coastal area, as well as the existence of multiple evacuation routes and other safety measures opportunities for residents made this approach for *Tanakahama* possible. Accordingly, *Tanakahama* beach will be equipped with measures against tsunami disaster risks that utilize the disaster prevention function of coastal forests while making good use of protection by disaster prevention facilities.

The plan for *Kodanohama* will review the land use plan to designate as non-residential areas districts with a risk of flooding if a 2011 scale tsunami hits. In residential areas, existing roads can be used as evacuation routes. It thus has been decided to reconstruct the seawall of T.P. +3.5 metres high on the beach near the shoreline, also as it was before the earthquake, and develop disaster prevention coastal forests, taking it as a prerequisite that adequate safety measures, such as development of an emergency evacuation protocol, will be implemented for the sake of community members.

Thanks to these plans, landscape, the natural environment, and tourism comprised mainly of nature experience programmes that utilize ecosystem services provided by the national park have been conserved while reconstruction and rehabilitation works progresses. These approaches coincide with the wish of local community members, that is, reconstruction as a sustainable area in which human activities are in harmony with nature.

The Ministry of the Environment of Japan, the managing authority of the national park, has developed a centre for *Tanakahama* nature experience programmes promotion near the beach and an emergency evacuation route to reduce tsunami disaster risks. For *Kodanohama*, an evacuation route for visitors has been established by *Kesennuma* City.

SEA-LEVEL RISE

Sea levels are rising around the world, due to complex phenomena including large-scale melting of polar ice caps and glaciers, changing vertical height of continents, thermal expansion of the oceans and by the use, depletion and discharge of groundwater sources. The extent to which this is happening greatly varies around the world. Sea-level rise has been occurring throughout much of the 20th and 21st centuries, and is likely to continue. This will have enormous impacts on human communities: 10 per cent of the world's population lives in coastal regions less than 10 metres above current sea level[24]; and 60 per cent of the world's largest cities exist within 100 km of the ocean [25].

What the Intergovernmental Panel on Climate Change says

'*sea-level rise and human development are together contributing to losses of coastal wetlands and mangroves*', which is, as a result, '*increasing damage from coastal flooding in many areas*' [26].

What can protected areas do to help?

Wide beaches and high dunes dissipate wave energy and dunes provide protective barriers between the ocean and inland property. Salt marshes, mangroves and other forested estuarine wetlands act as the frontline coastal defence. In particular mangroves can have a regulating effect by protecting shores from storm surges and waves and by preventing erosion. They also help filter pollution from freshwaters that enter the ocean.

What can't they do?

Protected areas cannot stop the sea rising and may themselves become vulnerable to permanent inundation, further reducing their buffering effect.

Can protecting natural ecosystems ever make things worse rather than better?

Not directly, but there will likely be increasing tension between management of coastal protected areas and surrounding coastal communities.

What does this mean for protected area planners?

Natural barriers may be shifted inland as sea level inundates their former habitat; but this will only be possible if there is space for them to migrate (or be artificially relocated). Those planning protected areas today need to consider the projections of sea-level rise and include higher ground for the mangroves and coastal forests in the future. As coastal areas are often heavily populated, such design considerations will often need to be carefully negotiated with local communities.

In some cases, decisions to abandon coastal settlements that cannot realistically be protected from rising seas may open up additional opportunities for protected areas. Here careful liaison will be needed with DRR specialists, protected area managers and surrounding communities to ensure that these new protected areas address both biodiversity conservation and coastal protection. The social resistance to these decisions should not be underestimated. At the same time it provides an opportunity to increase awareness and understanding of these changes in the communities, as they will likely be affected as well.

What does this mean for protected area managers?

Management of coastal vegetation, coral reefs and sand dunes is a critical step in protecting inland areas from sea-level rise. We still know little about how fast such changes will occur and whether ecosystems will have the ability to move themselves through natural processes or will need help – for example through planting, dune formation and similar. Managers need to monitor the situation carefully and have pre-arranged plans for how to respond if ecosystems appear in danger of being overwhelmed, particularly in areas where coastal erosion is increasing.

What does it mean for DRR specialists?

DRR specialists in many countries are already identifying coastal communities, infrastructure and habitats that governments will or will not attempt to maintain in the face of climate change. These situations provide important opportunities to include protected areas as tools to reduce risks. First, establishment of protected areas in places vulnerable to sea-level rise can directly protect communities. Secondly, protected areas can provide additional buffering for important wildlife habitat.

Best practice for using protected areas to address sea-level rise

- Manage, restore and where necessary relocate natural buffers like mangroves and sand dunes so that they provide maximum coastal protection.
- Include regular studies of changes in coastal vegetation within monitoring systems to allow sufficient time to respond to any changes.
- Develop cooperation between DRR and protected area specialists to ensure that strategies for management of coastal change include protected areas as tools for both coastal protection and biodiversity conservation.
- Use results from monitoring to raise awareness and educate the surrounding communities about sea-level rise, the potential impacts and the need for better protection.

For an example, see case study of Senegal on page 23.

CASE STUDY

MANAGING PROTECTED AREAS TO PROVIDE RESILIENCE AGAINST CLIMATE CHANGE: THE CASE OF THE SALOUM DELTA, SENEGAL

© Radhika Murti

In Senegal, degraded lands in the Biosphere Reserve of the Saloum Delta are being restored by local communities in order to increase their resilience in the face of climate change.

Located at the juncture of the Saloum River and the North Atlantic, the Biosphere Reserve of the Saloum Delta is experiencing a general trend of plant resource degradation due to several factors, including agricultural encroachment, high domestic fuelwood use and land salinization. In this region most people rely on agriculture, as well as livestock farming, fishery, tourism and salt extraction for their living. These activities put them at risk in the face of climate change whose effects – droughts, floods, soil salinization and erosion – are already visible. Together with forest resources degradation, these factors are leading to a decrease of natural resource availability and to soil infertility.

The protected area acts as a buffer against coastal erosion and flood risks, and provides ecosystem goods and services on which people rely for their livelihood. Its multiple features such as wetlands, marine and estuarine areas, lakes and marshes all play a role in protecting neighbouring villages from natural hazards. It thus plays an essential role in flood control and ensures a regular distribution of rainwater to plants and animals throughout the year. Furthermore, the presence of the reserve contributes to the existence of a favourable microclimate protecting against temperature fluctuations.

Through the Ecosystems Protecting Infrastructure and Communities (EPIC) project, IUCN is working with community members and local authorities to reforest areas, restore degraded lands and establish institutional mechanisms for regulating natural resource use in the protected area, through:

1. The 'Assisted Natural Regeneration' technique is being used to restore and conserve up to 90 ha of forest resources within the reserve, thus improving soil quality and biodiversity in the area. This technique contributes to carbon sequestration and thereby to climate change mitigation as well as to sustainable management of natural resources, and protection against soil erosion.
2. The construction of anti-salt bunds with local materials slows inland salt intrusion and helps to recover saline lands for cultivation. Through the project, up to 180 ha of land is being restored in a participatory process by using this technique. This will, on the one hand, eliminate the cause of salinity and, on the other, retain freshwater ultimately leading to improved soil fertility and increased yields up to about 40 per cent.
3. Developing mechanisms for regulating the exploitation of forest resources and fisheries is a priority in this region where natural resources are quickly disappearing. Together with the reserves' authorities and relevant local stakeholders for natural resources management, the project is supporting the implementation of regulating systems for forest exploitation as well as sustainable fisheries.

The project highlights the importance of integrating traditional knowledge into ecosystem-based approaches for climate change adaptation. Participatory approaches for restoring the protected area not only enhance the knowledge and adaptive capacities of rural communities, but also ensure the sustained provision of ecosystem goods and services and promote a diverse range of co-benefits, thus increasing the cost effectiveness of the activities. The holistic approach adopted by EPIC demonstrates that economic development, poverty alleviation and environmental conservation are not mutually exclusive.

Further information: www.iucn.org/epic

AVALANCHES AND LANDSLIDES

Avalanches are caused by weaknesses in the snowpack. They may be of variable size depending on snowpack properties and the level of accumulation, and can occur at any time of the year snow is on the ground. ***Landslides*** consist of earth and rock movement down slopes and can occur any time but are most likely after earthquakes or heavy rain. Two types of landslide occur: ***shallow landslides*** made up of slippage of earth, typically to a depth of 1-2 metres on steep slopes where debris moves quickly and ***deep-seated landslides***, which usually extend to the bedrock. The greatest risk from all of these is burial and physical impacts on people, infrastructure and settlements in areas down-slope of these hazards. It is estimated that avalanches killed half a million people around the world in the 20th century and over 3,000 people a year continue to die in landslides; some years' figures are two or three times higher[27]. These are relatively small numbers compared to other disasters caused by natural hazards (or to deaths from causes such as traffic accidents) but landslides tend to be under-reported and have a high impact on people's livelihoods.

What the European Commission says

'The reforestation of hill slopes can help to reduce the occurrence of shallow but still dangerous landslides (mainly mud flows and debris flows)' and again that *'excessive deforestation has often resulted in a landslide'*[28].

What can protected areas to help?

Forests maintained on slopes can protect valley communities by stabilising snowpack and soil and providing a physical barrier to earth and snow movements. Maintaining natural forests and other vegetation on steep slopes helps in two ways:

- Presence of dense and healthy root systems helps to bind soil together and stop a slide from starting, by pinning the snow pack to the ground and preventing the start of a shallow mud slide.
- Trees and bushes can help by improving anchoring of snowpack to the ground and provide barriers that stop or slow movement of snow and earth.

Research shows that forests may decrease the *number* of avalanches and landslides, but not necessarily their *severity* (i.e., once snow or mud is moving and has gained momentum, trees often won't be enough to halt the movement).

What can't they do?

Natural vegetation is often ineffective in preventing deep-seated landslides and won't stop the largest avalanches as evidenced by vegetation of short stature in avalanche run-out zones. Tussock vegetation has been identified as contributing to the occurrence of some avalanches at ground level (due to providing a slippery surface) although other smooth ground surfaces with a lack of anchoring may have similar effects.

Can protecting natural ecosystems ever make things worse rather than better?

Generally not, this is a no-risk insurance strategy. An exception would be if DRR specialists relied wholly on the properties of protected areas to manage these hazards. Both of these hazards are characterised by processes that may be managed to a degree at their source within a protected area, for example by restoring badly degraded vegetation on steep slopes. However, a combination of other management strategies is typically needed to address disaster risk down-slope of the start zones for these hazards. In both cases choice of strategy depends in part on the nature of human activities in down-slope areas together with the potential magnitude of hazard events.

What does this mean for protected area planners?

Countries like Switzerland and Japan have deliberately focused on protecting forests on steep slopes as an insurance against earth and snow movements. Incorporating such areas into protected areas often makes sense; they are set aside from management anyway and can provide additional benefits. Steep slopes are unlikely to be in high demand for much else (except ski slopes in some regions) so setting aside areas as forests is also a relatively easy decision politically.

What does this mean for protected area managers?

The principal management implication is to maintain healthy forest cover on slopes in avalanche and landslide prone areas, and restore forests if they have been degraded. Some tree species are particularly adapted to conditions of avalanche and landslides; these should be priorities in any restoration programme.

What does it mean for DRR specialists?

This is an area where DRR specialists in many countries have long recognized the role of natural vegetation although there is still capacity building needed in other places.

For an example, see case study of Chile on page 25.

Best practice for using protected areas to mitigate avalanches and landslides

- Include forested slopes in protected area systems as a way of reducing occurrence of avalanches and shallow landslides.
- Tailor management of steep slopes to maintain forest cover, including through restoration where necessary.
- Integrate protected areas management with engineered methods and built barriers where necessary to maximize security of communities below steep slopes.
- Integrate protected areas with other forms of control (which may also be applicable in adjacent areas especially down-slope) such as warning signs, closure of areas when avalanche hazard is high). Provide visitors to protected areas with clear guidance on the nature of hazards within the protected area and strategies to avoid them (for example guidance on avoiding travel through avalanche run-out zones and information on how to recognize them).

CASE STUDY

PROTECTING AGAINST SNOW AVALANCHES OR LANDSLIDES WITH FORESTS ON STEEP SLOPES: THE CASE OF THE BIOSPHERE RESERVE NEVADOS DE CHILLÁN, CHILE

© Alejandro.Casteller

In the Biosphere Reserve Nevados de Chillán, in Chile, sound science and community efforts are used to inform sustainable sylvicultural management of this mountainous area, in order to better mitigate climate- and human-induced avalanche risks.

Silvicultural management in mountain regions plays an important role, not only in altering avalanche frequency but also in developing overall, cost-effective defence measures against natural hazards. Indeed, if a forest has a protective function against avalanches, then expensive alternatives (snow supporting structures) do not have to be considered. Sound management of the forests is therefore crucial for protecting local communities from increased avalanche risk.

UNESCO declared the Biosphere Reserve Nevados de Chillán – Laguna del Laja in June 2011. The Reserve, located in the northern part of Patagonia within the central Chilean zone, in the Biobío Region, has an area of 565,807 ha. Snow avalanches threaten human settlements and transportation lines in this mountainous region. The Reserve seeks to reconcile conservation of biological and cultural diversity and economic and social development through partnerships between people and nature, and is thus ideal to test and demonstrate innovative approaches for disaster risk reduction.

Through the Ecosystems Protecting Infrastructure and Communities (EPIC) project, IUCN is working with the Swiss Institute for Snow and Avalanche Research (SLF) so as to increase knowledge about forest – avalanche interactions and to deduce adaptive strategies for the management of the Reserve's forests. Building on existing work by SLF, risk analyses under various land-use and climate scenarios are being carried out and utilised to inform sylvicultural management in Nevados de Chillán, so as to improve the protective role of forests in avalanche hazard mitigation. Local communities are taking a proactive role in this project through the promotion of sustainable management and conservation of native forests and through the establishment of an agency to promote eco-tourism and conservation of the Biosphere Reserve.

The different stakeholders of the project are working together so that: 'The Biosphere Reserve Nevados de Chillán – Laguna del Laja landscape, by empowering the local community with stakeholder support, contributes to improving the well-being of those who live and work in the reserve, through the sustainable use and conservation of natural resources'. The EPIC project is therefore contributing to an overall vision for community development, improved sustainable use and conservation of natural resources, and protection of the community's natural, economic and social assets in the Biosphere Reserve.

Further information: EPIC website: www.iucn.org/epic and SLF website: www.slf.ch

DROUGHTS

Climate change is increasing the frequency and severity of droughts, which can have a devastating impact on people directly reliant on local or regional agriculture[29]. Hydrological and agricultural changes can be exacerbated by a range of social, economic and political factors. Crops fail and livestock perish; one drought can destroy a family's hard earned security and leave them immediately at risk of death. Droughts also kill sensitive vegetation in drylands, breaking up the soil surface and increasing the risks of erosion, soil loss, desertification and dune formation, reducing the ecosystem's ability to withstand future droughts in a downward spiral of degradation.

What can protected areas do to help?

Protected areas cannot reduce large-scale drought, but they can provide a vital safety net to beleaguered communities and can help prevent droughts from leading to wider ecological breakdown. Key roles:

- Forest areas can provide emergency sources of wild food, water, local medicines and animal fodder during periods of drought. Clearly this has implications for management; drought-struck communities could quickly undo years of patient conservation work by over-harvesting. But managed access to resources can often help keep people alive until the rains or food relief comes without undermining long-term conservation goals.
- Maintenance of natural vegetation that includes drought resistant plants can provide sustainable grazing in protected landscapes. In many cases over-grazing leaves herders at risk of even small changes in weather patterns. Controlled grazing means less livestock but greater resilience.
- Maintaining ground cover in protected areas can also stabilise soil and provide living barriers to degradation, desertification and large-scale movements of sand and soil.
- By protecting ground and surface water sources, protected areas can also increase net water availability, often far away downstream in the watershed.
- Providing examples of best pasture management in times of drought.
- Large protected areas may also affect micro-climates and directly reduce local drought incidence.

What can't they do?

Protected areas cannot support large refugee communities sustainably if people have been displaced from their lands by sudden drought; arrangements for grazing and food collection are likely to be sustainable only with local communities that have long-term links with and understanding of the land. Nor will individual protected areas be enough to stop large-scale land degradation as a result of drought; although arid land vegetation can help stabilise individual areas it can be overwhelmed by drifting sand from elsewhere.

Can protecting natural ecosystems ever make things worse rather than better?

There can be tension between conservation priorities and the immediate needs of hungry people in times of drought, particularly if the protected area has better food and grazing. How much to allow people to degrade a protected area in an emergency is a decision that needs to be taken on an individual basis; in cases of serious disaster conservation objectives may be disregarded in any case.

What does this mean for protected area planners?

Locating protected area systems to include water sources can provide long-term benefits to nearby human communities and should be done in coordination with water authorities and agricultural ministries. Planners can also work with soil scientists to increase protection, and introduce stricter levels of protection in areas prone to desertification (for example by controlling over-grazing and off-road vehicles).

What does this mean for protected area managers?

Managers need to be aware of potential pressures on the protected area networks from human communities in times of drought. Are there pastoralists nearby who are likely to enter the area in search of grazing for their stock? Prior arrangements need to be negotiated with nearby farmers and subsistence users and may need to be re-negotiated quickly in times of emergency. Flexibility during drought can build long-term support but conversely can set a precedent for exploitation that may need to be addressed once conditions improve.

What does it mean for DRR specialists?

A thorough understanding of what protected areas can and cannot offer in periods of drought is essential for long-term DRR planning in arid zones.

For an example, see case study of Manas National Park in India on page 27.

Protected areas can provide a vital safety net to beleaguered communities and help prevent droughts leading to wider ecological breakdown

Best practice for protected areas and drought responses

- Work out agreements with relevant local and nomadic communities related to access and use of resources (grazing, collection of fodder, collection of non-timber forest products) before a drought takes place and work to ensure compliance in the event of a crisis.
- Maintain or restore ground vegetation, through agreements with farmers and pastoralists, the control of off-road vehicles and where necessary active restoration efforts.
- Pay particular attention to protection of surface and groundwater sites and to their catchments, to maximize water availability.
- Introduce use of sustainable gravity water flow schemes or water pumps to provide water to communities outside protected areas for home-based/small-scale irrigation, thus reducing pressure on protected natural ecosystems.
- Maintain bee habitats to ensure cross-pollination of crops to increase food security.

CASE STUDY

PRESERVING TRADITIONAL KNOWLEDGE TO HELP REDUCE RISKS IN PROTECTED AREAS: THE CASE OF MANAS WORLD HERITAGE SITE AND BIOSPHERE RESERVE, INDIA

© Sonali Ghosh

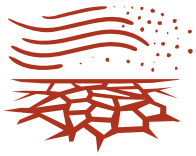
In the Manas Biosphere Reserve, in India, indigenous tribes have successfully demonstrated the use of century old traditional knowledge for channelling seasonal Himalayan rivers, helping reduce soil erosion and floods and ensuring the availability of irrigation and drinking water in an otherwise water deficient region.

Spanning across 2,837 km² of forest area, Manas Biosphere Reserve is designated as a UNESCO World Heritage Site for its outstanding natural beauty, ongoing ecological processes and several endemic and endangered species. Located on the eastern edge of the Biosphere Reserve, Subankhata Reserve Forest falls under the Bhabhar region, which is characterized by rocky terrain as well as course-changing, seasonal Himalayan rivers. The water table becomes very low and almost inaccessible during the dry season (October to April), whilst it is a region of heavy rainfall (> 3000 mm) other times of the year. The undulating terrain and loose lateritic soils make the area prone to floods and massive erosion in the downstream areas of major rivers. People living in the Reserve are poor and entirely dependent on rain-fed agriculture which is also their primary occupation.

In order to respond to the multiple water-related hazards that they were facing, indigenous inhabitants of Subankhata Reserve Forest initiated the construction of Dong Bundhs (small canals) on the Pagladiya River using locally available material such as timber, bamboo and boulders. Popularly known as the Dong Bundh system of Subankhata forest (DBSSF), these community-constructed micro-dams help in reducing soil erosion and floods, and significantly contribute towards DRR in the downstream agricultural areas. Building on their success, more settlements were gradually established and expanded to cover a significant portion of the catchment area. At present, there are 13 DBSSFs with inhabitants from more than 95 villages managing the irrigation system, which benefits a population of over 36,000 people. DBSSF has been highly beneficial to the villagers in multiple ways. Major floods, resulting erosion and landslides in the lower catchment have been avoided. Additionally, communities are able to harness water resources through the critical dry months and do not depend on artificial water supplies. As a bonus they are able to harvest at least four different cash crops throughout the year.

While local governments have struggled to fully exploit the water potential or to use modern technology, such as check-dams, the community in Manas Biosphere Reserve has been able to develop and preserve an indigenous water management practice that has benefitted the Reserve immensely. This practice of constructing micro-dams, channelizing and regulating water as per a systematic plan is almost a century old now, and has ensured the protection of key water sources within the protected area. It is critical to identify and to document such traditional practices, surviving within the periphery of protected areas, and to encompass them in the overall management of protected areas.

Source: Das, B. et al. 2014. 'Chapter 7: Traditional knowledge, ecosystem services and disaster risk reduction in Manas World Heritage Site and Biosphere Reserve, India' in Murti, R. and C. Buyck. (Eds.). *Safe havens: Protected Areas for Disaster Risk Reduction and Climate Change Adaptation*. IUCN, Gland, Switzerland.



DESERTIFICATION AND DUST STORMS

Desertification is the process of land degradation in the arid, semi-arid and dry sub-humid areas ('drylands') reflecting a persistent reduction or loss of biological and economic productivity. It usually involves loss of natural vegetation, often loss of water bodies; breakdown of soil structure; and major levels of soil erosion. Accompanying phenomena include dust storms and sand dune formation and movement. Desertification is caused by a mixture of pressures including deforestation, over-grazing and other unsustainable agricultural practices, and changes in climate that increase aridity. Desertification affects over a hundred countries and 1.5 billion people depend on degrading land[30].

What can protected areas do to help?

Healthy desert vegetation dramatically reduces rates of wind and flood related soil erosion, thus greatly reducing dust storms (and associated respiratory diseases) and desertification. Sustainable management practices and restoration in protected areas can also show local people the possibility of different approaches to management in areas where deserts have become accepted as an inevitable part of life.

What can't they do?

Individual protected areas cannot overcome a widespread desertification process on their own, and even healthy habitats can be overwhelmed by drifting sand in cases of large-scale desertification.

Can protecting natural ecosystems ever make things worse rather than better?

Management strategies in arid land protected areas usually mean reducing or eliminating livestock; this could in theory increase pressure in other parts of the ecosystem. There is intense debate about whether lack of grazing can also be a long-term problem in arid environments (which are adapted to low-level grazing).

What does this mean for protected area planners?

Location of protected areas in arid regions needs to take account of micro-topography, likely water flow, proximity to human settlements and roads, likely pressures etc. in order to maximize the wider ecosystem benefits. Buffer zones around settlements can reduce the impacts of dust storms for instance and protecting slopes can radically reduce soil erosion.

What does this mean for protected area managers?

Management is complex; sometimes protected areas have undergone impressive vegetation regeneration simply by reducing the number of domestic livestock. In other cases, complete protection (including fencing the perimeter) and costly replanting has been needed to regain vegetation cover. Artificial restoration is possible but quite slow and usually very costly, such as where expensive artificial irrigation systems are needed to help plant establishment.

What does it mean for DRR specialists?

Desertification is a creeping disaster that receives insufficient attention from the international community; deserts and dust storms have become so pervasive in some parts of the world that they are regarded as the natural state of affairs rather than as a result of mismanagement of natural ecosystems. When action is taken it is often either through expensive engineered solutions or resource-intensive afforestation. The role of restoration of natural ecosystems is often ignored, but is technically perhaps the easiest option (there may however be considerable social barriers). Collaboration with natural resource managers, conservation biologists and protected area planners is needed to develop these opportunities.

What the United Nations says

*'Where conservation or the creation and expansion of protected areas is appropriate and feasible, this should be encouraged so as to enhance connectivity, increase buffer zones and improve the provision of important ecosystem services, such as water p*rovision, pollination and genetic flows, to the surrounding production landscapes'[31].

Best Practice for using protected areas to prevent dust storms and desertification

- Locate protected areas as buffer zones around settlements or at the edge of desert areas to slow the rate of soil erosion and reduce levels of dust storms.
- Maintain or more likely restore vegetation through grazing control, prevention of off-road vehicles and where necessary active restoration programmes.
- Encourage sustainable grazing practices in protected landscapes and other less strictly protected areas.

For an example, see case study of South Africa on page 29.

CASE STUDY

LAND RESTORATION AGAINST DESERTIFICATION IN A SEMI-ARID AREA OF SOUTH AFRICA

From 2007 to 2013, a land restoration project has been undertaken in three semi-arid protected areas of South Africa, in order to increase vegetation cover and prevent desertification.

The Fish River Nature Reserve, Baviaanskloof Nature Reserve and Addo Elephant National Park are three protected areas located in the Albany Thicket Biome of South Africa, a biota of high conservation value which provides water for surrounding urban areas. Desertification is one of the greatest risks from climate change for semi-arid areas, mainly due to higher temperature and more erratic rainfall. The Albany Thicket is no exception to this threat, and is also undergoing intensive goat pastoralism which affects species diversity, soil quality and soil carbon stocks, leading to increased risk of desertification. Climate change as well as over-utilization of lands both exacerbate droughts and soil erosion and therefore adversely impact ecosystem functioning, the livelihoods of the local population and ecotourism.

Restoring degraded lands within the protected areas is expected to increase vegetation cover, improve the potential for water infiltration, reduce soil erosion, increase carbon sequestration and provide alternative opportunities for diversification of land use options. The planting of a local species, spekboom (*Portulacaria afra*), is ensuring the success of the restoration initiatives, because it has a high rate of primary production and helps to recruit additional species, preventing the land from becoming a monoculture. The species also promotes increasing soil moisture, which rises from 37±3% in degraded sites to 51±5% beneath spekboom canopy[32].

Healthy protected areas can help maintain a healthy water balance, and can also assist in mitigating climate change through carbon sequestration. Furthermore, well-managed protected areas provide multiple co-benefits such as harvest of medicinal plants, sustainable use of livestock and bee keeping, and help to revive the rural economy. The restoration of these three protected areas is being used as a pilot project for the rehabilitation of degraded areas from which lessons learnt will be used for scaling up restoration activities.

Source: Sigwela, A., Cowling, R., and A. Mills. 2014. 'Chapter 14: Contribution of protected areas in mitigation against potential impacts of climate change and livelihoods in the Albany Thicket, South Africa' in Murti, R. and C. Buyck. (Eds.). *Safe havens: Protected Areas for Disaster Risk Reduction and Climate Change Adaptation*. IUCN, Gland, Switzerland.

WILDFIRE

Protected area managers have a complicated relationship with fire. In fire-prone areas such as boreal forests and eucalyptus forests in Australia, they are often under intense social and political pressure to carry out 'prescribed burns' to reduce fuel load and avoid catastrophic fires that threaten lives and property beyond the protected area. In areas that are not naturally fire-prone, such as tropical moist forests, and where fire is used as a land clearance tool, one of the principal aims of management may be to prevent fires. In protected landscapes where subsistence agriculture is allowed, the management role may be to schedule and control prescribed burns. Managed use of fires may also be used as a way of maintaining grassland and savannah habitat. The link between biomass burning and increased carbon dioxide emissions is adding an important additional layer of complexity to this mix. While climate change is increasing the chances of fire in places that have not usually burned, and increasing the frequency and severity of fire in fire-prone ecosystems.

What can protected areas do to help?

Presence of managers and rangers provides expert advice on managing fires in a range of ecosystems (including advice on setting prescribed fires to reduce risk of wildfire).

In fire-prone areas:

- Protected areas provide management capacity to limit fire, through prescribed burning and other management approaches, in forests, savannahs etc.
- They also frequently have warning systems, watch towers, fire-fighting equipment that can help fire control beyond their own borders.

In areas that are not naturally fire-prone

- Primary forest in moist tropical forest areas is far less susceptible to wildfire than degraded secondary forests, thus protected areas can reduce the risk of fire occurring or spreading.

What can't they do?

Ultimately fires are a matter of chance (and sometimes deliberate arson) and land management strategies can reduce but not eliminate risks of catastrophic wildfires. Climate change is increasing the number and severity of fires.

Can protecting natural ecosystems ever make things worse rather than better?

Yes. In fire-prone areas poor management can increase the risk of intense fires by allowing flammable material to build up; in areas where social considerations make wildfire something to be avoided then management is often a trade-off between a hands-off approach and a fire-control approach. Poor management of a protected area can increase the risks. Protected areas may also attract more people into a region, as tourists and also perhaps as settlers around the edge of the forest (because of the resources it contains in poor countries or because of scenic beauty in rich countries), thus increasing the risk of accidental fire.

What does this mean for protected area planners?

In fire-prone areas, or areas where deliberate fire-starting is a problem, protected area systems need dedicated fire management strategies and expertise. Access to fast response teams is also an important consideration for risk management in some situations. Protected area planners need to increase their use of information such as satellite data for real-time planning.

What does this mean for protected area managers?

Wildfire is a challenge: management only really gets noticed if it fails. Protected area managers in areas prone to fire need to have and to implement fire management policies, tailored to individual conditions, but it is also important to make sure local people, local government officials and surrounding land-owners know what these are. Good liaison work will help fire management to be effective but can also help to deflect criticism if things go wrong – which inevitably they sometimes will. Managers also need to ensure that visitors to protected areas know the dangers of fire and are aware of how to prevent accidental fires from occurring.

What does it mean for DRR specialists?

In fire-prone areas, careful regional or national-level planning is needed to identify where wildfires can and cannot be safely permitted, including in protected areas, and to manage these sites appropriately, through such actions as prescribed burning, maintenance of fire breaks and safety precautions when fire occurs. In areas where natural fire would not usually occur but where fires caused by humans are a problem, DRR specialists can usefully liaise with protected area planners to identify intact forests where protection can help buffer larger areas and provide resources for their protection.

Best Practice for managing protected areas and wildfires

- Plan protected area fire management strategies on a national or regional scale, tailored to particular conditions (presence of human communities, proximity to other forests, risks of fire during high risk periods etc.).
- Maintain detailed fire prevention, management and safety strategies, particularly in protected areas that are heavily visited.
- Provide visitors with advice and instructions about preventing accidental fire.
- Coordinate between different stakeholders to address prevention and control of wildfire.

For an example, see case study of Lebanon on page 31.

CASE STUDY

MANAGING PROTECTED AREAS TO REDUCE FIRE RISK: THE CASE OF QADISHA VALLEY WORLD HERITAGE SITE IN LEBANON

© P.Regato

A study from the Global Fire Monitoring Center (GFMC) assessed fire risk in the Qadisha Valley, in Lebanon, and proposed an action plan to address the most appropriate measures that could be implemented in the World Heritage site, in order to prevent damage or destruction of this area of high natural and cultural value.

The Qadisha Valley was declared a UNESCO World Heritage Site in 1998 because of the remarkable biological, cultural, historical and religious assets it comprises, including ancient Christian monastic settlements. However, the integrity of the valley is at risk[33]. In particular, the problem of land-use change, with settlements being abandoned and land coming out of cultivation, has resulted in the build-up of live and dead vegetation increasing the wildfire risk in the area. It is therefore important to manage the protected area to effectively reduce the risk of wildfires that could possibly destroy the valuable natural and cultural assets and also endanger the local population.

Based on this observation, GFMC undertook a study in 2010 in order to: 1) Assess fire risk in the area, and 2) Propose a fire management plan. The results indicate a high fire risk in the protected area, driven by change in land-use, vegetation growth and tourism. The main steps recommended for reducing fire risk include fire hazard mapping, vegetation treatment for creating fuel breaks at strategic locations, public education, capacity building of firefighters and park rangers, and investment in infrastructure such as water access points.

The implementation of this strategy, based on improved protected area management, will substantially reduce the risk of wildfires in Qadisha Valley World Heritage site. Such technical measures combined with awareness raising and capacity building have proven effective for fire risk reduction in Lebanon as well as in other Mediterranean countries.

Source: Forest Fire Threat in Qadisha Valley, Lebanon: Precautionary Action to Prevent Damage or Destruction of the UNESCO World Heritage Site. Report of an Initial project, submitted to UNESCO by the Global Fire Monitoring Center (GFMC), 2010. http://www.fire.uni-freiburg.de/Manag/GFMC-UNESCO-Quadisha-Valley-Lebanon-Fire-Report-Brief.pdf

EARTHQUAKES

Major earthquakes can result in huge loss of life and damage to property: at the time of the earthquake itself; in the days or weeks afterwards due to landslides and avalanches caused by the movement; and from diseases and other problems that come in the wake of widespread damage to infrastructure, transportation and sanitation. Around a fifth of global fatal earthquake events include deaths from secondary causes[34]; these secondary effects are of greatest interest here. As always, poor people in poor countries suffer disproportionate damage.

What can protected areas do to help?

The principal roles of protected areas in the case of earthquakes are in:

✔ The prevention or mitigation of associated hazards including particularly landslides and rock falls in mountainous areas.

✔ Providing zoning controls to prevent settlement in areas most susceptible to earthquake-related impacts (e.g., areas prone to liquefaction of waterlogged soils) or in places that are likely to suffer particular damage from secondary causes (e.g., under steep slopes prone to rock fall, beside lakes or reservoirs that may burst their banks, etc.).

What can't they do?

The main mitigation role of protected areas only addresses a relatively small number of the considerations required to address the topic of risk reduction for earthquakes. Experience shows that buildings and infrastructure built to withstand earthquakes is the most effective way of reducing casualties, together with zoning decisions to address situations where this is not feasible or cost effective.

Can protecting natural ecosystems ever make things worse rather than better?

Protected areas that maintain vegetation on slopes are usually a no risk strategy.

What does this mean for protected area planners?

Planners responsible for designing local or national protected area networks should always look at stabilising steep slopes (and not just to defend against earthquake damage). Extending the protected area to prevent settlement in places likely to be at particular risk from earth movements could also help to reduce risks.

What does this mean for protected area managers?

Managers can help by taking particular care to maintain or where necessary restore forest and other vegetation on steep slopes in earthquake prone areas. They will need plans for dealing with emergencies in terms of their own staff and visitors, but may also be the first professionals on call in remote areas with first aid and other equipment following an earthquake.

What does it mean for DRR specialists?

In mountainous areas, earthquake response strategies should minimize risks from aftershock landslides and rock fall through maintenance of forested slope, coupled with warning signs and physical barriers when slope stability is a continuing problem.

Best Practice for managing protected areas and earthquakes

- In earthquake prone areas, incorporate steep slopes above settlements into protected area networks and manage to ensure a healthy forest cover, to minimize risk of landslide damage following earth movements.
- Use protected areas and buffer zones as tools to control settlement in areas particularly at risk in the event of earth movements.

Natural forests on steep slopes help to prevent post-earthquake landslides

VOLCANOES

Large volcanic eruptions are spectacular, newsworthy events, which are still difficult to predict and impossible to prevent: disaster risk focuses on minimising risks to people, usually by trying to predict when an explosion is likely and moving people out of range. The idea of using protected areas to mitigate some of the risks by buffering slopes and areas around a volcano is just being developed and is presented here in abbreviated form. Much more research is needed on this and related issues.

What can protected areas do to help?

Forests and woodlands can help to slow the rate of movement of lava and also provide some shelter against ash and flying debris. Valleys and debris flow channels may be important in channelizing and containing flows from eruptions. Where these features can be identified they may be excellent candidates for inclusion in protected areas. If already protected, they should be managed in a manner which recognizes their function as a potential flow path.

What can't they do?

As with all natural hazards, there are limits to what natural buffers and exclusion zones can do. A huge eruption will not be stopped by a forest.

Can protecting natural ecosystems ever make things worse rather than better?

This seems to be a low risk policy, although if lava starts fires in forested slopes these could spread and cause further damage.

What does this mean for protected area planners?

If research shows this provides tangible risk reduction benefits it may be worth focusing more attention on the options for designating protected areas on the slopes of volcanoes (although the rich lava soils have made them prime sites for terrace farming in some parts of the world).

What does this mean for protected area managers?

Incorporation of natural vegetation into DRR volcano planning would mean giving greater emphasis to forest conservation on volcanic slopes and in surrounding areas. Areas recognized as flow paths will require specific management strategies that may include access restrictions and emergency evacuation protocols.

What does it mean for DRR specialists?

Natural vegetation and protected areas have been virtually ignored to date; further work is needed on this option.

BEST PRACTICE FOR PROTECTED AREAS AND DRR: SUMMARY OF KEY POINTS

- Build good working relations between DRR specialists, protected area authorities and other relevant authorities to ensure that everyone understands what they can contribute to DRR strategies, through development of collaborative working groups or similar (protected areas should be represented on regional disaster planning committees).
- Integrate protected areas with any engineering responses to DRR, to ensure that these are mutually supportive and that one approach does not undermine the other.
- Provide visitors to protected areas with clear guidance on avoiding danger from extreme climatic events, earth movements and other natural hazards.
- Incorporate early warning systems regarding natural hazards into protected area management and where appropriate use protected area monitoring systems to feed into national early warning systems.

Cyclones, typhoons and hurricanes

- Maintain natural barriers (forests, mangroves, coral reefs, coastal marshes, barrier islands and sand dunes) in storm-prone areas, particularly along coasts where human communities have been established.
- Where necessary restore natural barriers that have disappeared, by active planting or seeding, active restoration of land barriers and / or through removal of pressures.
- Introduce protected area zoning that incorporates DRR elements.

Flooding

- Design protected area systems to include a range of natural floodplains and wetlands that can absorb and store flood water, and include natural forests on steep slopes and next to watercourses, to provide maximum buffering potential.

- Ensure that vegetation is in good health and resilient to natural flood patterns, including through restoration.
- Build good working relations between DRR specialists, protected area and water authorities to ensure that everyone understands what they can contribute to flood prevention strategies. This can be achieved through development of collaborative working groups and representation of protected areas on regional disaster planning committees.
- Include integrated water management elements and watershed approaches into protected area planning to connect protected areas better to the surrounding hydrological system.

Tsunamis

- Maintain natural barriers (forests, mangroves, coral reefs, barrier islands and sand dunes) in tsunami-prone areas, particularly along coasts where human communities have been established and where coastal geography is likely to increase the height and speed of the approaching wave.
- Where necessary restore natural barriers that have disappeared, either by active planting or seeding, and / or through removal of pressures.
- Practice integrated planning for DRR; avoid placing engineering barriers in sites where they undermine the effectiveness or existence of natural barriers.

Sea-level rise

- Manage, restore and where necessary relocate natural buffers like mangroves and sand dunes so that they provide maximum coastal protection.
- Include regular studies of changes in coastal vegetation within monitoring systems to allow sufficient time to respond to any changes.
- Develop cooperation between DRR and protected area specialists to ensure that strategies for management of coastal change include protected areas as tools for both coastal protection and biodiversity conservation.
- Use results from monitoring to raise awareness and educate the surrounding communities about sea-level rise, the potential impacts and the need for better protection.

Avalanches and landslides

- Include forested slopes in protected area systems as a way of reducing occurrence of avalanches and shallow landslides.
- Tailor management of steep slopes to maintain forest cover, including through restoration where necessary.
- Integrate protected areas management with engineered methods and built barriers where necessary to maximize security of communities below steep slopes.
- Integrate protected areas with other forms of control (which may also be applicable in adjacent areas especially down-slope) such as warning signs, closure of areas when avalanche hazard is high). Provide visitors to protected areas with clear guidance on the nature of hazards within the protected area and strategies to avoid them (for example guidance on avoiding travel through avalanche run-out zones and information on how to recognize them).

Droughts

- Work out agreements with relevant local and nomadic communities related to access and use of resources (grazing, collection of fodder, collection of non-timber forest products) before a drought takes place and work to ensure compliance in the event of a crisis.
- Maintain or restore ground vegetation, through agreements with farmers and pastoralists, the control of off-road vehicles and where necessary active restoration efforts.
- Pay particular attention to protection of surface and groundwater sites and to their catchments, to maximize water availability.
- Introduce use of sustainable gravity water flow schemes or water pumps to provide water to communities outside protected areas for homebased/small-scale irrigation, thus reducing pressure on protected natural ecosystems.
- Maintain bee habitats to ensure cross-pollination of crops to increase food security.

Desertification and dust storms

- Locate protected areas as buffer zones around settlements or at the edge of desert areas to slow the rate of soil erosion and reduce levels of dust storms.
- Maintain or more likely restore vegetation through grazing control, prevention of off-road vehicles and where necessary active restoration programmes.
- Encourage sustainable grazing practices in protected landscapes and other less strictly protected areas.

Wildfire

- Plan protected area fire management strategies on a national or regional scale, tailored to particular conditions (presence of human communities, proximity to other forests, risks of fire during high risk periods etc.).
- Maintain detailed fire prevention, management and safety strategies, particularly in protected areas that are heavily visited.
- Provide visitors with advice and instructions about preventing accidental fire.
- Coordinate between different stakeholders to address prevention and control of wildfire.

Earthquakes

- In earthquake prone areas, incorporate steep slopes above settlements into protected area networks and manage to ensure a healthy forest cover, to minimize risk of landslide damage following earth movements.
- Use protected areas and buffer zones as tools to control settlement in areas particularly at risk in the event of earth movements.

All ecosystem services that provide DRR rely on healthy, functioning ecosystems, so that along with the specific actions outlined above, steps that ensure logical planning, good governance and effective management of protected areas will generally contribute to effective DRR.

FOR DRR PLANNERS: INTEGRATING PROTECTED AREAS INTO DRR STRATEGIES

Integration will involve recognising the role that protected areas may play in DRR, and then working with protected area authorities, local communities, conservation biologists and ecosystem service specialists to identify opportunities for Eco-DRR. Tool 4 below matches risks with ecosystem services with what protected areas can offer.

TOOL 4: MATCHING HAZARDS, ECOSYSTEM SERVICES AND PROTECTED AREAS

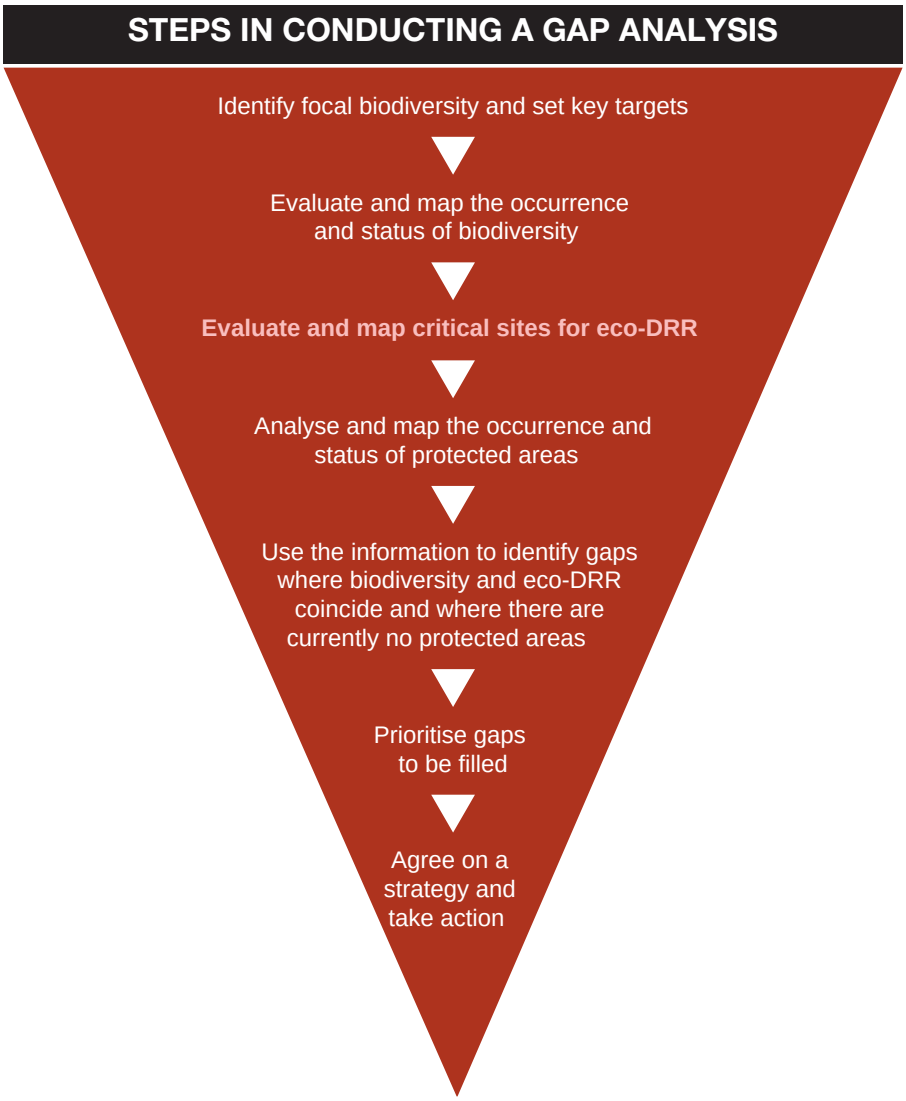
Hazard	Ecosystem service / hazard prevention	Role of protected areas
Floods	• Temporary storage in natural wetlands • Regulation of water flow	• Protecting natural floodplains • Restoring natural flow patterns in rivers • Protecting wetlands and marshes to act for spillover and ponding
	• Buffering effect of woodlands beside waterways and on steep slopes	• Protecting riparian and mountain forests • Restoring degraded forest to help soak up water
	• Preventing settlement in flood-prone areas	• Zoning restrictions in Category V protected areas to maintain flood control systems
Drought, desertification & dust storms	• Maintaining natural vegetation and drought resistant plants to slow soil erosion, prevent desertification, maintain grazing options	• Protection of natural vegetation • Restoration where necessary • Agreement of sustainable grazing regimes in protected landscapes
	• Emergency sources of wild food and animal fodder during periods of drought	• Protecting natural forests in drought-prone areas • Restoration where necessary • Agreement on sustainable use within protected landscapes
Typhoons, hurricanes & tsunamis	• Physical protection against storms and ocean surge	• Protection of coral reefs, sand dunes, barrier islands, mangroves, coastal marshes and coastal and inland forests
Sea-level rise	• Physical protection against sea-level rise	• Protection, active management and where necessary relocation of coastal ecosystems
Avalanche & landslides, earthquakes	• Using forest cover to reduce likelihood and impacts of snow avalanches and shallow landslides	• Protect and where necessary restore forests on slopes in high-risk areas
Wildfire	• Buffering against fire through retention of primary forest	• Maintaining primary forest in areas where fire is not naturally prevalent
	• Managing risk in fire-prone areas	• Prescribed burning, fire prevention training, enforcement of fire regulations
Volcanic eruptions	• Forests can slow the rate of lava flow when volcanoes erupt	• Maintain forest cover on slopes of active volcanoes

FOR PROTECTED AREA PLANNERS: INTEGRATING DRR INTO NATIONAL PROTECTED AREA PLANS

- Whether DRR benefits can be included into existing protected area systems drawing on the best practice guidelines outlined in the manual (without undermining the primary nature conservation purposes of protected areas).
- Working out the social, cultural and economic values of DRR and using these; in approaching local communities, in defence of protected area policies and as a potential way of helping to support the protected area management in financial terms.
- Incorporating DRR into plans for extending the protected area system.

Tool 5 below lays out a simple approach to incorporating Eco-DRR into a standard protected area gap analysis used to identify potential new sites for protected areas[35]. Each step is described in detail opposite.

TOOL 5: STEPS IN CONDUCTING A GAP ANALYSIS TO IDENTIFY POTENTIAL PROTECTED AREAS THAT WOULD ALSO SUPPORT ECO-DRR



1. **Identify focal biodiversity and other conservation objectives, and set key targets**: goals can relate to area planned for protection or to the conservation of specific targeted species or ecosystems ('focal biodiversity').
2. **Evaluate and map the occurrence and status of critical biodiversity**: biodiversity information is often very incomplete at a national level so gap analysis relies on data (1) for well-known species (e.g., mammals, birds, higher plants) (2) for a few key species from other groups that are representative of particular habitats and (3) for ecosystems. Studies involve consolidating diverse data sets; using geographic information systems; and standardising habitat and land-use classification systems.
3. **Evaluate and map critical sites for Eco-DRR**: this will need to be done in collaboration with DRR experts, identifying disaster-risk areas where natural ecosystems remain and provide protection, or where degraded ecosystems could be restored.
4. **Analyse and map the occurrence and status of protected areas**: basic information on protected area size and location is usually available at national level. Information about status of protected areas is generally less available, although studies are starting to emerge.
5. **Use the information to identify gaps**: maps of occurrence and status/ecological need of species and ecosystems are then overlaid on maps of Eco-DRR priorities and maps of occurrence and management status of existing protected areas and any gaps identified. *A gap analysis for protected areas should focus first on biodiversity,* but ecosystem services can provide invaluable additional reasons for including an area within a national protected area network.
6. **Prioritize gaps to be filled**: further analysis is needed – of threats, opportunities and to some extent also capacity – to identify a series of priorities for action; that is the gaps where action is most urgently required.
7. **Agree on a strategy and take action**: there are many different ways of filling the gaps. There is a range of different management objectives within protected areas, and many different ways in which these areas can be governed. Strategies may therefore involve developing new protected areas, enlarging existing protected areas and through other forms of land and water management including easements, ecological corridors, buffer zones and sustainable management approaches.

It follows that if DRR values are going to be factored into protected area planning, one or more DRR specialists will need to be part of any national or regional planning team.

WORKING OUT THE SOCIAL, CULTURAL AND ECONOMIC VALUES OF DRR FROM PROTECTED AREAS

Valuation needs care: care to get right and care to use without reducing everything to simple financial considerations. But as we learn more about valuation, methods are being applied that look at both economic and other values; that ensure all stakeholders have a role in valuation; and that can provide powerful arguments for using protected areas as tools for DRR.

Economic arguments can persuade governments to employ protected areas for DRR

- The Whangamarino Ramsar site in New Zealand has flood control values estimated at US$601,037 per annum (2003 values) rising to US$4 million in years of serious flooding[36].
- Muthurajawella Marsh, near Colombo, Sri Lanka, has an estimated flood attenuation value of US$5,033,800 per annum (2003 values)[37].
- In Switzerland, protection forest on steep slopes provides services estimated at between US$2 and 3.5 billion per year[38].
- An initial investment of US$1.1 million in mangrove restoration saved an estimated US$7.3 million a year in sea dyke maintenance in Viet Nam[39].
- Research in Indonesia calculated the erosion control value of mangroves as being equivalent to US$600 per household per year[40].

Knowing the economic value of DRR from protected areas can help persuade authorities to invest in their creation and management

TOOL 6: VALUATION TOOLS FOR DRR IN PROTECTED AREAS

Many tools already exist for assessing and sometimes quantifying ecosystems services, including those that will be useful to DRR in protected areas. A selection of the best are outlined below.

VALUATION TOOLS

Natural Capital Project – InVEST and RIOS (Resource Investment Optimization System)

http://www.naturalcapitalproject.org/InVEST.html

InVEST can model and map the delivery, distribution, and economic value of ecosystem services. This tool helps users visualize the impacts of potential decisions, identifying trade-offs and compatibilities between environmental, economic, and social benefits.

Ecosystem Services Partnership

http://www.es-partnership.org/esp/79128/5/0/50

An international network of practitioners and researchers working on ecosystem services, aiming to share information, tools and experience relating to ecosystem services; includes a valuable database of valuation tools.

Earth Economics – Ecosystem Valuation Toolkit

http://esvaluation.org

The world's first comprehensive collection of online tools and resources for planners, watershed managers, forest owners, natural resource agencies, scholars and businesses to research and communicate the value of nature's capital assets.

ARIES

http://ariesonline.org

ARIES is a new methodology and web application meant to assess the ecosystem services and illuminate their values to humans in order to make environmental decision-making more effective.

Advanced Terrestrial Ecosystem Analysis and Modelling (ATEAM)

https://www.pik-potsdam.de/ateam/

ATEAM's main objective is to assess and model the vulnerability of human sectors relying on ecosystem services provided by major European terrestrial ecosystems with respect to global change.

CLIMSAVE Platform

http://www.climsave.eu/climsave/index.html

CLIMSAVE is an interactive, exploratory, web-based tool for assessing climate change impacts and vulnerabilities on a range of ecosystem services related to the following sectors, agriculture, forests, biodiversity, coasts, water resources and urban development. The Platform integrates a suite of sectoral models to simulate spatially the negative or positive effects of different climate and socio-economic scenarios on ecosystem services across Europe, allowing the evaluation of cross-sectoral benefits, conflicts and trade-offs.

Ecosystem-based Management (EBM) Tools

http://www.smartgrowthtools.org/ebmtools/index.php

Ecosystem-Based Management (EBM) is a holistic approach to the management of coastal and marine resources. It considers all ecosystem components, including humans and the environment, rather than managing one issue or resource in isolation. EBM tools are software or other processes that can help implement EBM by:

- Providing models of ecosystems or key ecosystem processes
- Generating scenarios illustrating the consequences of different management decisions on natural resources and the economy
- Facilitating stakeholder involvement in planning processes

ValuES Methods Database

http://www.aboutvalues.net/method_database/

This database contains profiles of a diverse range of methods, tools and sources, and includes extensive fact sheets on more than 60 ES assessment methods.

MIMES – Multiscale Integrated Models of Ecosystem Services

http://unstats.un.org/unsd/envaccounting/seeaRev/meeting2013/EG13-BG-6.pdf

MIMES is a model suite for land use change and marine spatial planning. The models quantify the effects of changes in land and sea use on ecosystem services and can be run at global, regional, and local levels. MIMES simulates ecosystems and socio-economic systems in space and over time as well as the interactions between these systems. It incorporates stakeholder input and biophysical data from GIS sources, time series, among others, to simulate ecosystem components under different scenarios defined by stakeholder input. These simulations can help stakeholders evaluate how development, management and land/sea use decisions will affect natural, human and built capital.

SolVES (Social Values for Ecosystem Services)

http://solves.cr.usgs.gov/

SolVES (Social Values for Ecosystem Services) is a GIS Application for assessing, mapping, and quantifying the social values of ecosystem services. SolVES derives a quantitative, 10-point, social-values metric, the Value Index, from a combination of spatial and non-spatial responses to public value and preference surveys. It also calculates metrics characterizing the environment, such as average distance to water and dominant land cover.

TESSA
http://tessa.tools/
TESSA is an alternative to sophisticated methods for assessing ecosystem services. The toolkit focuses on specific sites such as a wetland, a mountain or a reserve to bring assessments on an operational scale using information gathered locally. The toolkit provides different methods for assessing global climate regulation, flood protection, water provision, water quality improvement, harvested wild and cultivated goods and nature-based recreation. For getting a broader view of ecosystem service change, the toolkit provides guidance on how to pull together the service-by-service data into an ecosystem service overview of a site. The aim is to make assessments relevant for local decision-making and, when scaled up, for wider communication.

Protected Area Benefit Assessment Tool (PA-BAT)
http://wwf.panda.org/?174401/PABAT
The PA-BAT uses a simple questionnaire approach in a workshop setting to bring together diverse groups of stakeholders to identify the different types of benefits derived from protected areas and also who benefits and how much; it tries to reveal the degree to which particular benefits are linked to protection strategies. The PA-BAT aims at assessing legal resource use and the benefits potentially accrued from that use. The assessment may also identify ecosystem services that are neglected but could actually deliver higher benefits.

And see also the following two books:
Fabrice Renaud, Karen Sudmeier-Rieux and Marisol Estrella (eds). 2013. *The Role of Ecosystems in Disaster Risk Reduction*, UNU-Press.
Sue Stolton, Nigel Dudley and Jonathan Randall. 2008. *Natural Security: Protected areas and hazard mitigation*, WWF, Gland, Switzerland.

CASE STUDY

INVESTING US$ 1 IN A MARINE PARK IN BARBADOS COULD SAVE US$ 20 IN LOSSES FROM HURRICANES

Damage from weather events in Barbados could significantly increase due to climate change. The Economics of Climate Adaptation Working Group, a 7-partner cluster[41], has developed a methodology to integrate climate adaptation with economic development and sustainable growth.

In Barbados, damage from wind, storm surge and inland flooding already amounts to between 4 and 6 per cent of GDP annually. By 2030, in a high climate change scenario, losses could rise by 1 to 3 per cent of GDP per year (US$ 279 million)[42]. The 'Economics of Climate Adaptation' (ECA) methodology has been carried out in more than 20 countries or cities worldwide, including Barbados. The overall objective of the ECA methodology is to offer decision makers a scientific approach to help them to integrate climate adaptation in their future development strategies.

In Barbados, the main results indicate that:

- Investing US$ 1 million in protecting the Folkestone Marine Park (FMP) and ensuring reef and mangrove protection and revival can lower losses by US$ 20 million per year.
- Investing in coastal mangroves protection in the FMP can reduce damage from storm surges: one hundred metres of mangroves can reduce storm wave energy by 90 per cent for waves up to 6 m[43].
- Presently, mangroves are viewed negatively due to their smell, mosquitoes and because they prevent access to beaches. FMP's mangroves not only require financial resources but also awareness building programmes in order to change the negative perception of people and to make the case for mangroves' benefits.

Source: Mueller, L., and D. Bresch. 2014. 'Chapter 2: Economics of climate adaptation in Barbados – facts for decision making' in Murti, R. and C. Buyck. (Eds.). *Safe havens: Protected Areas for Disaster Risk Reduction and Climate Change Adaptation*. IUCN, Gland, Switzerland.

FOR PROTECTED AREA MANAGERS: MANAGING FOR DRR

Protected area managers should be empowered to develop disaster resilient programmes and projects. Managing for DRR in protected areas is on the whole simply good management overall; a healthy, functioning ecosystem will likely deliver its expected ecosystem services. But when there are potential DRR values recognized in a protected area, a smart manager will take steps to make sure they deliver the widest possible range of benefits. If people are living inside or adjacent to a protected area, pro-active management may be needed to ensure that hazards emanating from inside the protected area, such as wildfire or avalanche, do not cause human casualties. Care needs to be taken throughout that a narrow focus on DRR does not result in management undermining other core values, such as biodiversity values. Several steps are important:

1. Identify all the actual or potential DRR values from a protected area, list and describe these; if possible these should also be quantified in terms of economic benefits, number of people provided with protection, type and range of benefits etc. Such material should be included in leaflets, signs and websites about the protected area.
2. Where appropriate, incorporate DRR considerations into protected area management plans and include a DRR specialist on the management committee.
3. Ensure that any beneficiaries are aware that the protected area is providing them with additional security against disasters: through written material, presentations, organized visits and similar – invitations to a protected area to see the values for themselves can be very valuable, and a stock of photos of DRR in action should be built up if possible (e.g., the protected area acting as a flood plain).
4. List the implications for management in terms of:
   a. Day-to-day management steps: such as providing additional protection for important features
   b. Emergency management steps, that need to be taken quickly if a natural hazard occurs (these should also be well known to authorities responsible for DRR planning)
   c. Any changes needed in management, such as restoration of features that have a particular DRR value (degraded mangroves, forests on steep slopes, wetland connectivity etc.)
   d. Any changes needed to overall policy, such as increasing level of protection of the site, expanding the area or changing the boundaries, which need higher level decisions within the protected area agency or beyond.
5. Investigate the potential to incorporate DRR efficiently into overall management plans, for instance, through exploring the potential for additional funding sources such as Payment for Ecosystem Service schemes, or new political backers.
6. Implement any actions to improve the DRR potential, identified in point 5 above
7. Ensure that protected area management decisions do not increase vulnerability of resident and surrounding human communities to natural hazards.

RESTORATION FOR DRR

One implication of using protected areas for DRR is that managers may give higher priority to restoration of natural ecosystems in places where they have degraded and have a potential DRR function. Indeed recognition of DRR values may help to find funding for such initiatives. Furthermore, if a disaster occurs, during the recovery phase the issues of protected areas restoration, re-zonation and boundary alteration should be integrated in the overall land use management. In 2012 IUCN produced best practice guidelines for restoration in protected areas: a summary of key elements are reproduced below.

Key messages from 2012 best practice guidelines on restoration in protected areas

- Identify major factors causing degradation—undertaking restoration without tackling underlying causes is likely to be fruitless
- Set clear restoration objectives—it may not be appropriate to aim for a 'pristine' or 'pre-disturbance' state, particularly under conditions of rapid environmental (e.g., climate) change
- Ensure a participatory process involving all relevant stakeholders and partners in planning and implementation, facilitating participation and shared learning, contributing to acquisition of transferable knowledge, improving visitor experiences, and celebrating successes
- Recognize that some objectives or motivations for restoration may conflict and work collaboratively to prioritize among them
- Ensure that the time frames for objectives are clear
- Assess the possible impacts of climate change and other large-scale changes on the feasibility and durability of restoration and try to build resilience
- Ensure that monitoring addresses the full range of restoration objectives and the intermediate stages needed to reach them
- Use monitoring results and other feedback in adaptive management
- Restore, where possible, ecosystem functioning along with physico-chemical conditions and hydrology
- Consider natural capital, ecosystem services, disaster risk reduction and climate change mitigation and adaptation
- Identify potential negative impacts of the restoration programme and take action to limit or mitigate them as much as possible
- Identify and where possible control external factors such as pollution that may compromize restoration efforts[44].

CASE STUDY

RESTORATION OF TWO USA NATIONAL PARKS ON THE NORTHERN GULF OF MEXICO FOLLOWING HURRICANE KATRINA

Following the 2005 Hurricane Katrina, restoration of two coastal National Parks in the US States of Mississippi and Louisiana were initiated. The overall objective was to restore offshore barrier islands and wetlands – coastal marshes and swamps – so as to improve the efficiency of natural ecosystems in reducing disaster risks in the New Orleans region.

In August 2005 Katrina hit the coast of Louisiana and Mississippi states, causing respectively 1,557 and 279 deaths and significant damage estimated at US$ 81 billion. On the Mississippi coast, the storm surge ranged from 7 metres to 8.5 metres along a 32 km stretch of coast, the highest ever recorded in the USA, and waters travelled 19 km inland. Besides taking lives, the hurricane had a notable effect on the local economy, in particular on tourism.

There is strong evidence that coastal swamps, marshes and barrier islands played a key role in the protection of coastal communities. Healthy coastal ecosystems provide valuable services in terms of disaster risk reduction. In the case of Hurricane Katrina, these included:

- reducing storm surge from 5cm/km to 25cm/km (although this depends on bathymetry, topography and plant types);
- protecting hurricane protection levees;
- protecting communities without hurricane protection levees.

The National Parks of Jean Lafitte National Historic Park and Preserve (JELA NHPP) and Gulf Islands National Seashore (GUIS-MS) were directly impacted by Hurricane Katrina, but had also undergone previous natural hazards and degradation by human activities. Degradation of these parks, comprising many barrier islands and coastal wetlands, is making them less effective in buffering extreme weather events, which leads to exacerbated disaster risk. Their restoration is therefore essential to allow them to continue playing their role of barrier against future coastal hazards. Based on this need, the US Congress voted for major investments towards restoring the two parks, including the following activities:

- Closing a cut made by Hurricane Camille in order to restore Ship Island: this operation (still in planning stage), is estimated to costs US$ 368 million and consists of placing about 17 million m^3 of sand to join the two islands, so as to restore the barrier island;
- Restoring canals by backfilling and using dredged materials for marsh nourishment in order to restore marsh health and thus help restore normal hydrology in the parks;
- Removing and controlling exotic plant species and planting desired species, in order to return the coastal ecosystems to healthy and functioning productive ecosystems that act as bio-shields.

This case study demonstrates that managing protected areas for mitigating hurricane and storm impacts is possible, and is even essential for allowing them to reduce disaster risk. Restoring degraded coastal areas provides a cost-effective solution for reducing disaster risk and protecting people from the adverse impacts of storms and hurricanes. Restoration costs for the two protected areas are estimated at US$ 450 million (including US$ 368 million dedicated to the closing of the cut), which remain low compared to the costs of damages caused by Hurricane Katrina, estimated at up to US$ 81 billion.

Source: Ford, M. 2014. 'Chapter 16: Hurricane Katrina, the role of US National Parks on the northern Gulf of Mexico and post storm wetland restoration' in Murti, R. and C. Buyck. (Eds.). *Safe havens: Protected Areas for Disaster Risk Reduction and Climate Change Adaptation*. IUCN, Gland, Switzerland.

APPLYING PROTECTED AREAS AS TOOLS FOR DRR: SOME UNDERLYING PRINCIPLES

Ecosystem services are not the only way to address disaster risk reduction, and protected areas are not the only tool for ecosystem services. But both are important and frequently overlooked or undervalued. The use of natural ecosystems for DRR has become known as Eco-DRR. The following seven basic principles outline how to maximize the potential and effectiveness of protected areas as tools for Eco-DRR. They are examined in more detail below.

TOOL 7: PRINCIPLES FOR ECO-DRR IN PROTECTED AREAS

1. **Always consider the use of natural ecosystems – Eco-DRR – in national, regional and local DRR plans**
2. **Always consider protected areas as a tool for Eco-DRR**
3. **Ensure that when engineering solutions to DRR are considered to be essential, they do not inadvertently undermine Eco-DRR opportunities or existence**
4. **Integrate DRR planning requirements into protected area gap analyses and regional planning**
5. **Identify Eco-DRR benefits in the management plan**
6. **Include Eco-DRR elements into protected area management effectiveness assessments**
7. **Ensure that protected areas do not increase vulnerability to resident or nearby human communities**

Always consider the use of natural ecosystems – Eco-DRR – in national, regional and local DRR plans: there is still a major need for social awareness and capacity building around the role of natural ecosystems in addressing DRR. There is already a huge global industry based around engineered solutions to DRR, which may on occasions increase resistance to new ideas.

Always consider protected areas as a tool for Eco-DRR: DRR specialists and protected area agencies should have active partnerships to look at the value of natural ecosystems within a defined and managed protected areas system. Some of the simple tools and checklists suggested in this handbookl could act as a first stage in incorporating protected areas into DRR planning.

Ensure that when engineering solutions to DRR are considered to be essential, they do not inadvertently undermine Eco-DRR opportunities or existence: for example, levees and dykes alongside rivers that block off flood plains may simply move the problem further downstream. Sea walls that isolate and degrade mangrove forests simply replace one sort of defence with another, which can have severe implications for ecosystem services such as filtering wastewater, protection of fisheries etc. Comprehensive DRR strategies tend to use a mixture of both engineering DRR and Eco-DRR.

Integrate DRR planning requirements into protected area selection (e.g., gap analysis) and regional planning: incorporating the potential DRR values when planning new protected areas, considering the implications for protected area location, size, design, overall management approach (IUCN category) and day-to-day management.

Identify Eco-DRR benefits in the management plan: this might include for example prioritising restoration of natural buffers, restoring flow patterns in freshwater systems and including consultation with DRR specialists in management effectiveness assessments. Identification in the management plan will help secure management effort and funding for DRR elements.

Include Eco-DRR elements into protected area management effectiveness assessments: by developing specific questions or assessment modules aimed at tracking effectiveness, including where possible economic assessments of DRR values.

Ensure that protected areas do not increase vulnerability to resident or nearby human communities: through insufficient management of natural hazards.

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Disasters caused by natural hazards like storms, floods, droughts and tidal surge costs billions of dollars and kill tens of thousands of people every year. Disaster risk reduction (DRR) specialists are increasingly looking at natural ecosystems for cost effective and efficient buffering against natural hazards. The world's protected area network is helping to maintain the natural ecosystems that support biodiversity and ecosystem services, including DRR. But what exactly do protected areas offer to DRR strategies? This manual gives concise information for DRR specialists, protected area managers and governments on choosing and managing protected areas to protect against natural hazards and thus prevent disasters from occurring.

PROTECTED AREAS AS TOOLS FOR DISASTER RISK REDUCTION

A handbook for practitioners

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