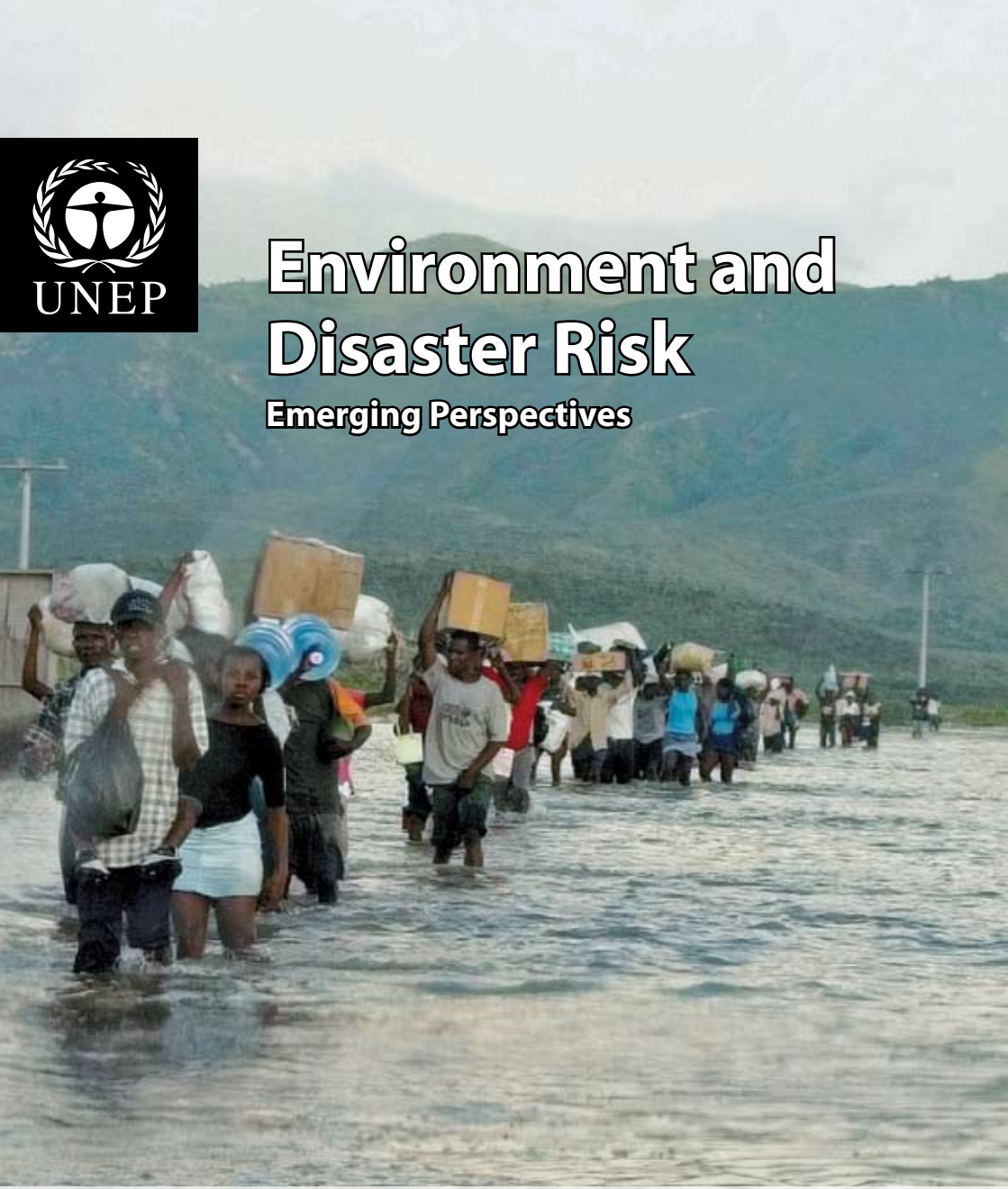
UNEP

Environment and Disaster Risk

Emerging Perspectives



ISDR

Prepared on behalf of the UN ISDR
Environment and Disaster Working Group

> The invoice for our climate-changing emissions will include more droughts, floods and other natural disasters. We need to 'climate proof' our farms, our infrastructure and our livelihoods in order to minimize our vulnerability to future disasters.
>
> *– Achim Steiner, UNEP Executive Director*

The UN ISDR Working Group on Environment and Disaster was established in 2005 and has benefited from the expertise of many organizations, including: United Nations University, Institute for Environment and Human Security (UNU-EHS), African Union Commission, Asian Disaster Preparedness Center (ADPC), Asian Disaster Reduction Center (ADRC), Council of Europe, Food and Agriculture Organization of the United Nations (FAO), Global Fire Monitoring Center, International Federation of Red Cross and Red Crescent Societies (IFRC), IUCN - The World Conservation Union, Red Cross / Red Crescent Centre on Climate Change and Disaster Preparedness, Pacific Disaster Center (PDC) , ProVention Consortium, United Nations Center for Regional Development (UNCRD), United Nations Development Program (UNDP), World Food Program (WFP) and World Meteorological Organization (WMO).

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Introduction

Melting glaciers, denuded slopes, expanding deserts – these images of environmental change have long captured public attention. With the threat of global climate change, the environment has moved from casual concern to the forefront of the international agenda. The scale of change is so great that society must now address the challenges of adapting to an altered environment while at the same time strengthening efforts to prevent further damage.

Scientists and decision makers have only recently recognized the need for policy to tackle the complexity of this interaction. Growing interest in adaptation to climate change is evidence of this realization. The scientific community now stresses that both the underlying causes of human vulnerability to hazards, and the role of environmental conditions in exacerbating those hazards should be taken into account.

This discussion paper aims to address the complexity of risk in this 'two-way system' between environment and human societies.



STILL PICTURES / UNEP – ANTONIO MACIAS MARTINEZ

Adrift in an urban park. Climate change is causing an increase in the frequency and intensity of extreme weather events.

Connections

The Hyogo Framework for Action, the Millennium Declaration and the UN Millennium Ecosystem Assessment have different points of departure but come to the similar conclusion that environmental degradation, poverty and disaster risk share common causes as well as common consequences for human security and well-being. They also make clear that ecosystem services, environmental management and environmental information offer opportunities to reduce risk, decrease poverty and achieve sustainable development.

In order to support advocacy, capacity-building and training programmes, and to facilitate the design and implementation of environmentally sound solutions to the challenges posed by hazards, there is now an urgent need to effectively communicate the strategic issues linked to addressing the environmental dimensions of disaster risk reduction.

This paper introduces the connections between the state of the environment and disaster risk, and identifies areas of action where disaster and environmental managers could make better use of environmental management to reduce disaster risk[1].

Disaster risk, development and the environment

Disasters are not random and do not occur by accident. They are the convergence of hazards and vulnerable conditions. Disasters not only reveal underlying social, economic, political and environmental problems, but unfortunately contribute to worsening them. Such events pose serious challenges to development, as they erode hard-earned gains in terms of political, social and educational progress, as well as infrastructure and technological development.

The Millennium Declaration recognizes the risk to development stemming from disasters and calls on the global community to "intensify our collective efforts to reduce the number and effects of natural hazards and man-made disasters"[2].

Several studies have recently highlighted the fact that investments in development are in jeopardy unless precautionary action is taken toward reducing disaster risk[3]. Yet few development organizations adopt a precautionary approach in the design and management of projects and fewer still recognize the role of environmental management in reducing disaster risk.



STILL PICTURES – MARK LYNAS

Waves from the atoll lagoon threaten buildings in Tuvalu, Funafuti, during exceptionally high tides in February 2002.

Environmental degradation, settlement patterns, livelihood choices and behaviour can all contribute to disaster risk, which in turn adversely affects human development and contributes to further environmental degradation. The poorest are the most vulnerable to disasters because they are often pushed to settle on the most marginal lands and have least access to prevention, preparedness and early warning. In addition, the poorest are the least resilient in recovering from disasters because they lack support networks, insurance and alternative livelihood options.

A comprehensive approach to disaster reduction acknowledges the role of the environment in triggering disasters and protecting communities. At the same time, it recognizes that the environment is itself vulnerable to disasters and post-disaster recovery. The potential contributions of environmental management (including environmental science, information, governance and technologies) towards reducing disaster risk. Most importantly, this approach recognizes the vital role of environmental managers, whether they live in rural villages or earn their livelihoods in the offices of government buildings.

Environment and disaster risk

That environment, development and disasters are connected is rarely disputed, but the multi-dimensional role of environment has caused considerable confusion. While it is often recognized that ecosystems are affected by disasters, it is forgotten that protecting ecosystem services can both save lives and protect livelihoods. The following framework maps five pathways that connect environment to disaster risk – and ultimately link environmental management to disaster risk reduction.

Environment and disaster: In terms[4]

Ecosystem: A functional unit consisting of all the living organisms (plants, animals and microbes) in a given area, as well as the non-living physical and chemical factors of their environment, linked together through nutrient cycling and energy flow. An ecosystem can be of any size – a log, a pond, a field, a forest or the Earth's biosphere – but it always functions as a whole unit.

Ecosystem services: The benefits people derive from ecosystems. These include provisioning services such as food and water; regulating services such as flood and disease control; cultural services such as spiritual, recreational, and cultural benefits; and supporting services such as nutrient cycling that maintain the conditions for life on Earth. The concept "ecosystem goods and services" is synonymous with ecosystem services.

Environment: All of the external factors, conditions, and influences that affect an organism or a community. Also, everything that surrounds an organism or organisms, including both natural and human-built elements.

Disaster: A serious disruption of the functioning of a community or a society causing widespread human, material, economic or environmental losses which exceed the ability of the affected community or society to cope using its own resources. A disaster is a function of the risk process. It results from the combination of hazards, conditions of vulnerability and insufficient capacity or measures to reduce the potential negative consequences of risk.

Disaster risk reduction: The conceptual framework of elements considered with the possibilities to minimize vulnerabilities and disaster risks throughout a society, to avoid (prevention) or to limit (mitigation and preparedness) the adverse impacts of hazards, within the broad context of sustainable development.

Environmental degradation: The reduction of the capacity of the environment to meet social and ecological objectives, and needs. Potential effects are varied and may contribute to an increase in vulnerability and the frequency and intensity of natural hazards. Some examples include: land degradation, deforestation, desertification, wildland fires, loss of biodiversity, land, water and air pollution, climate change, sea level rise and ozone depletion.

Path 1

Natural hazards are physical processes that can be directly affected by social processes.

Events such as floods, droughts and earthquakes are designated as 'hazardous' because they threaten human communities or the elements that we value. Hazards are expressions of the earth's physical processes. However, the myth that we have little influence over the occurrence of tropical cyclones or rainfall shortages has been exposed: human activities have an impact on the timing, magnitude and frequency of these physical processes. Human endeavours have triggered global warming and thereby affected the frequency and intensity of extreme climate events. On a local scale, deforestation and desertification have demonstrable effects on local rainfall patterns and are complicit with the occurrence of drought.



STILL PICTURES / UNEP – BINSYO YOSHIDA

Industrial pollution is contributing to the production of greenhouse gases – a major cause of global warming.

Climate change and hazard risk

Many of the impacts associated with climate change exacerbate or alter existing hydro-meteorological hazards, such as droughts, floods, storms and heat waves. Climate change is caused by the anthropogenic emission of greenhouse gases and leads to alterations in global climate patterns with shifts in local precipitation, temperature and weather patterns. According to the Intergovernmental Panel on Climate Change (IPCC), climate change will stress critical ecosystems and lead to water and food shortages this century.

Climate change is already evident in many parts of the world. Scientists are careful not to attribute a single event to climate change, but do acknowledge the growing frequency and magnitude of hazards in general. Although climate change can be addressed by limiting activities that cause greenhouse gas emissions, the scientific community agrees that too little has been done so far. People will need to adapt to face the impact from the change that is already unavoidable due to past greenhouse gas emissions.

In early 2007, the IPCC confirmed that adaptation to current weather extremes could increase resilience to climate change[5]. The first step towards climate change adaptation is to address existing vulnerabilities to these extremes. It is also important to address the more subtle but ongoing changes in average climatic conditions and climatic variability, which may affect the capacity to deal with hazards[6]. Many of the required climate change adaptation measures, such as early warning systems, risk assessment and the use of sustainable natural resources, are – in practice – disaster risk reduction activities.

Path 2

Healthy ecosystems often provide natural defences.

The UN Millennium Ecosystem Assessment recognizes floods and fires make necessary and valuable contributions to the environment and to human communities. It also draws attention to the significant services that ecosystems provide to human communities in regulating hazards. Ecological conditions not only modify the frequency and magnitude of hazard events, but also affect natural barriers that can moderate the impacts of a disaster and protect communities. Wetland ecosystems function as natural sponges that trap and slowly release surface water, rain, snowmelt, groundwater and floodwaters. Deforestation is often blamed for worsening the effects of flooding while mangroves, dunes and reefs create physical barriers between communities and coastal hazards.



STILL PICTURES / UNEP – S. ROCHA

A bend in the Iguaco River shows the contrast between dense forest and agricultural expansion. The undisturbed forest on the near bank is part of the Iguacu National Park.

Human factors in flooding: Dominican Republic and Haiti[7]

The May 2004 debris flow in Jimani, Dominican Republic killed an estimated 400 of the 11,000 Jimani residents, displaced up to 3,000 individuals, and destroyed at least 300 homes, or approximately 10 to 15 percent of the town's housing stock[8]. Primary causes were an intense rainfall event, the location of the town on an alluvial fan, and deforestation in the upper catchment. Secondary causes included the geomorphology of the area (poorly consolidated sediments, gravels and boulders), the hydrology of the watershed, and poor local capacity for weather forecasting, river monitoring, and communications/evacuation orders.

Arguably, the single most important factor driving the flash flooding event was a low-pressure system which originated in Central America and traversed Dominican Republic and Haiti between 18 and 25 May 2004. This system brought a combined total of over 500 mm of rainfall to the Haitian/Dominican Republic border regions – as much as the usual annual precipitation in the region.

Another key cause of the disaster was the physical site of the town of Jimani, which is located on an alluvial fan built from sediment deposited by thousands of years of flooding events[9].

The third primary cause of the disaster was deforestation in the upper catchment. Just over 80 percent of the Soliette river catchment is found within Haiti's borders, and the catchment drains across the border into neighbouring Dominican Republic. The Haitian portion of the catchment is "virtually treeless"[10], with some estimates suggesting that up to 97 percent of the original forest cover has been removed, most within the last 20 years.

Ecosystem services in hazard regulation[11]

Ecosystem	Role in Flood Regulation	Role in Fire Regulation
Cultivated	crop cover provides flood protection, conditioned in good management	part of the management of some cropping systems, e.g., sugar cane, timber, etc.
Dryland	protection through vegetation cover; recharge of aquifers	biodiversity issues: adaptation mechanisms to fire
Forest	protection from floods providing flood attenuation and soil loss prevention	part of the natural system; reducing wood fuel accumulation; biodiversity issues
Urban	move people away from flood-prone areas, conditioned on good urban planning	move people away from natural fire-prone areas; scale benefits from more effective fire prevention and control
Inland Waters	provide mechanisms for flood attenuation potential (wetlands, lakes, etc.)	wildfires control, e.g., pit fires control by wetlands
Coastal	benefits from sediment transport to the coastal zone; flood protection provided by coastal ecosystems (barrier beaches, mangroves, etc.)	not applicable
Marine	benefits from nutrient transport to the oceans	not applicable
Polar	discharge regulation to oceans in the Arctic system (freshwater provision to Arctic oceans)	not applicable
Mountains	regulating flood-related events (slope stability)	main source of wood fuel
Islands	benefits from sediment transport to oceans through floods from the mainland; aquifer recharge as main source of fresh water	not applicable



STILL PICTURES / UNEP – KEVIN LANE

View of a desert storm. Land degradation, including desertification, forces communities onto marginal lands and increases their vulnerability to disasters.

Path 3

Degraded ecosystems reduce community resilience.

The shift in focus from hazards to underlying vulnerabilities has provided disaster managers with a richer understanding of the factors that erode the coping capacities of communities and social systems. Environment plays a role in many of these factors. There is a strong causal relationship between poverty, a degraded environment and higher disaster risk.

People who live in marginal or environmentally degraded areas often struggle on a daily basis to survive and are unable to cope with any additional stress factors. Limited livelihood alternatives, competition over over scarce resources, weak governance structures and lack of access to healthcare and other services can compromise a community's ability to respond to and recover from a hazard event.

Environmental management and community based resource management can promote more resilient communities through supporting sustainable livelihoods, conflict prevention and strengthening cooperation for good governance.

Environmental impacts of post-tsunami reconstruction

A UNEP assessment of Aceh two years after the 2004 Asian tsunami clearly shows that the reconstruction process has significant impacts on the environment, even though many of the environmental problems that are visible now predate the tsunami. Some of the environmental concerns identified include:

- The locations chosen for the reconstruction of houses are not always adequate. Houses are sometimes built in highly disaster-prone or environmentally sensitive areas, or in areas where the water table is shallow.
- Inadequate or sometimes absent sanitation facilities for reconstructed houses are a major source of ground and surface water pollution, particularly in areas with very shallow water tables.
- The excessive use of burnt clay bricks for the reconstruction of houses, together with the fact that brick kilns mainly use production techniques with very low energy efficiency, results in a demand for huge quantities of fuel wood, which often comes from illegal logging operations.

Path 4

Some environmental impacts require immediate attention.

While the environment is generally able to recover from disaster events, environmental impacts can result in serious risk to life and livelihoods if not addressed:

(1) Environmental emergencies, defined as the uncontrolled, unplanned or accidental release of a substance into the environment; the risk of these types of emergencies arising from natural hazards will continue to increase as urban and industrial areas are developed without awareness of hazard risk: and

(2) Unplanned recovery processes that fail to take the state of ecosystems and ecosystem services into account: recovery is a period of immediate development, and without proper consideration of the environment, pre-existing vulnerabilities may be re-created or exacerbated. Even worse, the new situation may pose new risks.

Path 5

Environmental degradation is a hazard in itself.

Any discussion of environment and disaster would be incomplete without recognizing that environmental degradation is in itself a hazard – a man-made hazard. The loss of biodiversity or desertification, for instance, will continue to severely affect local communities and wider economic systems. The risk and vulnerability perspective

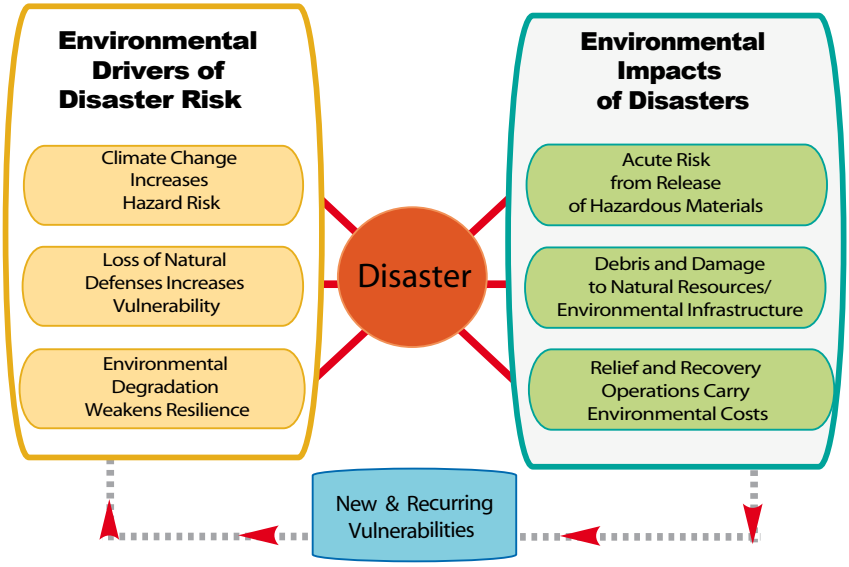


STILL PICTURES / UNEP – STEVEN POE

Loss of biodiversity leads to a decrease in ecosystem productivity, biological resources, ecosystem services and social benefits.

elaborated by the disaster reduction community also provides a valuable framework for analyzing patterns of vulnerability to environmental change and identifying opportunities for reducing that vulnerability.

Environmental causes and consequences



The Hyogo Framework for Action

In January 2005, countries at the World Conference on Disaster Reduction adopted the Hyogo Framework for Action (HFA)[12], which guides disaster risk reduction activities globally. The Hyogo Framework recognizes that environmental degradation contributes to disaster risk, and that disasters occur when hazards interact with, among other things, environmental vulnerability.

The document urges governments to pursue the "substantial reduction of disaster losses, in lives and in the social, economic and environmental assets of communities and countries". As such, the Framework recognizes both the role of environment as a trigger of disaster risk, and the sensitivity of the environment to the forces of hazards.

Human societies cannot be dissociated from the environments that they shape and which in turn influence their development and livelihoods. Together they form a comprehensive system with intrinsic levels of vulnerability and inherent coping mechanisms. The less degraded the environmental component of this system, the lower its overall vulnerability and the higher its coping capacity.

Reducing the underlying risk factors

The Hyogo Framework defines "reducing the underlying risk factors" as a Priority for Action and specifically recommends environmental and natural resource management and other efforts that:

(a) Encourage the *sustainable use and management of ecosystems*, including through better land-use planning and development activities to reduce risk and vulnerabilities;

(b) Implement *integrated environmental and natural resource management* approaches that incorporate disaster risk reduction, including structural and non-structural measures, such as integrated flood management and appropriate management of fragile ecosystems; and

(c) Promote the integration of risk reduction associated with existing *climate variability and future climate change* into strategies for the reduction of disaster risk and adaptation to climate change, which would include the clear identification of climate-related disaster risks, the design of specific risk reduction measures and an improved and routine use of climate risk information by planners, engineers and other decision makers.

Priorities for action

Environmental concerns and opportunities are relevant to the implementation of all disaster risk reduction priorities. The following section looks at the process of environmental management and suggests ways in which environmental managers can engage with disaster managers and other development partners to reduce disaster risk. These opportunities are organized to align with the five 'priority areas for action' outlined in the Hyogo Framework for Action and briefly described below.

HFA Priority 1: Ensure that disaster risk reduction is a national and local priority with a strong institutional basis for implementation.

The 2002 World Summit on Sustainable Development sharpened global awareness of the role of governance in reversing environmental degradation. Given that governance and institutions also play a critical role in reducing disaster risk, lessons should be sought from environmental managers who have, for decades, accumulated experience in mainstreaming an area of concern that cuts across sectoral boundaries and is challenged by pressures to favour short-term gains over long-term security.

Good governance is not only a matter of legislation: it is also based on appropriate, effective and flexible institutions. Regulatory frameworks need to be enforced, and the political will to balance competing interests and bring about the many changes that may be necessary must be continually reaffirmed. The creation and strengthening of national mechanisms such as multi-sectoral national platforms, and their integration within international governance mechanisms like conventions, are also important. Key options for improving how institutions address environment and disaster-related issues include fully engaging environmental managers in national disaster risk management mechanisms, and incorporating risk reduction criteria in environmental regulatory frameworks.

HFA Priority 2: Identify, assess and monitor disaster risks and enhance early warning.

Risk information helps answer questions such as where, when, how and why disasters are likely to occur. It comes in many forms, including telemetric data that alert to seismic activity in real time, climate projections that help explain long-term changes, and forecasts that indicate upcoming storms. In addition, risk information also conveys important descriptions of patterns and causes of vulnerability. Monitoring and observation of environmental conditions includes a mix of space- and ground-based systems. Environmental information is also the basis for spatial planning for identifying appropriate buffer zones, land uses or building codes. It feeds into the models, forecasts and projections that help anticipate and reduce risk. Because risk and vulnerability are dynamic, risk and vulnerability assessments must be continuous efforts.

HFA Priority 3: Use knowledge, innovation and education to build a culture of safety and resilience at all levels.

Disasters can be substantially reduced if people are well informed and embrace a culture of prevention. Local communities often maintain vast traditional knowledge on environment and disasters. Universities and other research centres have produced other information for policymakers and operational disaster managers. Still, new technical knowledge of risk reduction, based on environmental principles, needs to be developed.

Knowledge of the environmental dimensions of disaster needs to be made available for use in evidence-based analyses, public awareness, political advocacy, operational decisions and educational curricula.

HFA Priority 4: Reduce the underlying risk factors.

Natural resource exploitation, urban development and environmental degradation all directly affect risk. Changes in weather intensities, circulation, hydrology, and sea level brought about by climate change have increased risk. The loss of ecosystems services that regulate floods and fires increases the vulnerability of vast populations in densely populated coastal areas and flood plains.

Addressing the factors that create adverse environmental conditions requires strengthened governance systems, improved education, awareness and capacity building systems and appropriate technologies based on both scientific advances and traditional knowledge. Environmental management supports risk reduction through protecting and enhancing the ecological conditions that promote resilience and adaptation to a changing climate.

HFA Priority 5: Strengthen disaster preparedness for effective response at all levels.

The coordination of evacuation, search and rescue operations, and provision of relief to survivors relies on contingency plans developed in advance of the disaster event and based on all available risk information. To develop and implement effective plans aimed at saving lives, protecting the environment and protecting property threatened by disaster, all relevant stakeholders must be engaged: multi-stakeholder dialogue is key to successful emergency response.

Environmental managers must be prepared to deliver vital services. Damage to industrial facilities and environmental infrastructure can pose immediate risks to survivors and threaten public health. Recovery, if ill-planned, can re-create vulnerabilities, generate new risks and undermine sustainability and security. In both the relief and recovery phases, attention to the environment is first about saving lives and then about livelihoods.



The October 2005 earthquake in Pakistan, which caused this landslide at Muzaffarabad, continues to present recovery challenges.

Opportunities for risk reduction

1 Engage environmental managers fully in national disaster risk management mechanisms

Dynamic mechanisms for disaster risk reduction usually demonstrate strong national ownership and leadership of risk reduction activities. Not only should environmental concerns be fully integrated into such measures at the national level, but environment-related institutions should also become pillars of efforts to develop broader national systems for disaster risk reduction and sustainable development.

Other opportunities include involving environmental managers more closely in the relief and recovery processes that follow disaster events. Despite the environmental implications of disaster risk and vulnerability, and the long-term consequences for sustainable development, the role of environmental managers in disaster reduction, response or recovery has so far been ad hoc. Likewise, disaster managers have given little attention to the environmental aspects of their work and should regularly be engaged in environmental programs as partners.

Sri Lanka's Road Map for Disaster Risk Management

The Government of Sri Lanka has produced a landmark Road Map for Disaster Risk Management. Its key objectives are to:

- Complement the ongoing policy and legislative efforts with risk identification and reduction strategies;
- Strengthen national and local level institutions while paying due attention to Community-based Disaster Risk Management (CBDRM); and
- Consider the different kinds of hazard risks and vulnerabilities across the country, while formulating national- and provincial-level action plans for poverty alleviation and infrastructure development, which will enable the strengthening of local and national governance structures as well as emphasize national and community-based environmental resource management for long-term risk reduction.

The Road Map calls for a broad range of environmental initiatives and provides a costed plan with environmental management initiatives featuring urgent priorities. These include disaster impact assessments within environmental impact assessments, monitoring changes in hazard risk due to environmental trends, monitoring nuclear radiation, preventing and improving response to oil spills, soft engineering solutions to coastal protection (vegetation belts), solid waste management, and advocating for environmentally sound disaster reduction technologies.

2 Include risk reduction criteria in environmental regulatory frameworks

Environmental managers have successfully used a number of regulatory frameworks to prevent further environmental degradation by requiring developers to assess the potential environmental impacts of proposed plans and activities. A guidance note prepared by the ProVention Consortium (currently hosted by the International Federation of Red Cross and Red Crescent Societies) on the use of environmental impact assessment (EIA) methodologies as a tool for mainstreaming disaster risk reduction identifies three essential actions as part of the EIA process:

- The environmental assessment process should include collation of data on natural hazard-related risks as a fundamental first step in broader project scoping;
- Systematic analysis of natural hazards and related vulnerability should be undertaken as a central component of environmental assessment in areas of risk of natural hazards; and
- A full impact assessment should be required for certain types of projects in high-risk areas.

In addition to EIAs, a number of instruments are commonly used for country-level environmental analyses. Most notably, strategic environmental analysis (SEA), a methodology for developing concrete inputs to specific policies or plans, has been applied in at least fourteen countries in Asia, Latin America, Africa and Central Europe. The Government of Sri Lanka, for example, has recently pursued steps to institutionalise SEAs to review the environmental implications and options available in township development plans and explored the potential for integrating disaster risk concerns in SEA methodologies.

3 Assess environmental change as a parameter of risk

Risk assessments are the basis for risk reduction strategies and preparedness planning, and should be the foundation for development plans as well. Whether these assessments are carried out at the national or the community level, environmental change needs to be factored in as a parameter of risk. Evaluations of risk in coastal areas, for example, must account for rising sea levels and their impact on hazard zones.

The focus on environmental change as a parameter of risk also reminds us that risk is dynamic and changes over time. Risk assessments, therefore, need to account for dynamic risk through better models as well as frequently updated assessments.



STILL PICTURES – DOUGLAS FAULKNER

Kayangel Atoll in Palau, like other small island states, are in a particularly precarious position with regard to global sea level rise.

Mapping hazard risk is often a core function of the environmental management agencies that store baseline physical data and have well-established mapping capacities. Unfortunately, these maps are often unknown to other partners. Risk and vulnerability mapping, however, need to take social and economic information into account as well as physical parameters, particularly at the local level.

In addition to identifying hazard risk (from floods, landslides, seismic activity etc.), some environmental authorities have also mapped environmentally sensitive areas that could be affected by disaster. In Kenya, the KenSea Environmental Sensitivity Atlas for the Coastal Zone provides information about the spread and distribution of natural resources along the coast to support the command centre grappling with operational and political decisions in case of an oil spill.

4 Utilize local knowledge in community-based disaster risk management

Environmental conservation and disaster management are critical to the livelihoods of indigenous people who often live in hazard-prone areas. They have built up, through thousands of years of experience and intimate contact with the environment, a vast body of knowledge on hazards and the environment events. This knowledge is a precious resource that continues to contribute to environmental conservation and disaster management in these regions. With the disruption of traditional lifestyles and changing settlement patterns, it is a challenge to maintain the continuity of traditional knowledge through transmission from generation to generation. Indigenous knowledge should be considered as a complement to scientific knowledge in the development of community-based disaster risk management plans and programmes.

5 Engage the scientific community to promote environmental research and innovation

Science and technology are a critical foundation of disaster risk reduction and essential to the implementation of the Hyogo Framework for Action. However, the scientific basis for the linkages between environmental management and the intensity and frequency of natural hazards remains incomplete and lacks authoritative positioning by national and international institutions. While there are centres of excellence that can help deepen the understanding of these causal relationships, greater engagement of policymakers and operational managers can stimulate targeted and applied research that identifies new opportunities to reduce disaster risk. Broadly speaking, greater investments are required to identify technological alternatives and stimulate innovation in environmentally sound solutions to risk reduction.

Bangladesh supporting indigenous practices[13]

In Bangladesh, river-bed mud has been used for many years to raise homesteads above annual flood levels. People are encouraged to plant trees around their homesteads to prevent erosion and secure the soil. This small-scale structural mitigation measure is unique to the region.

The Asian Disaster Preparedness Centre, together with CARE Bangladesh, has encouraged and supported the continued use of this flood mitigation measure in the municipalities of Tongi and Gaibandha. The project initiated the partnership of local organizations and the municipal disaster management committee. Participation of key stakeholders, community leaders and members of the community was a vital component of developing a Disaster Risk Management (DRM) plan. The community was engaged to determine their vulnerability with the use of Participatory Rural Appraisal tools. This information was then used to develop a community DRM plan.

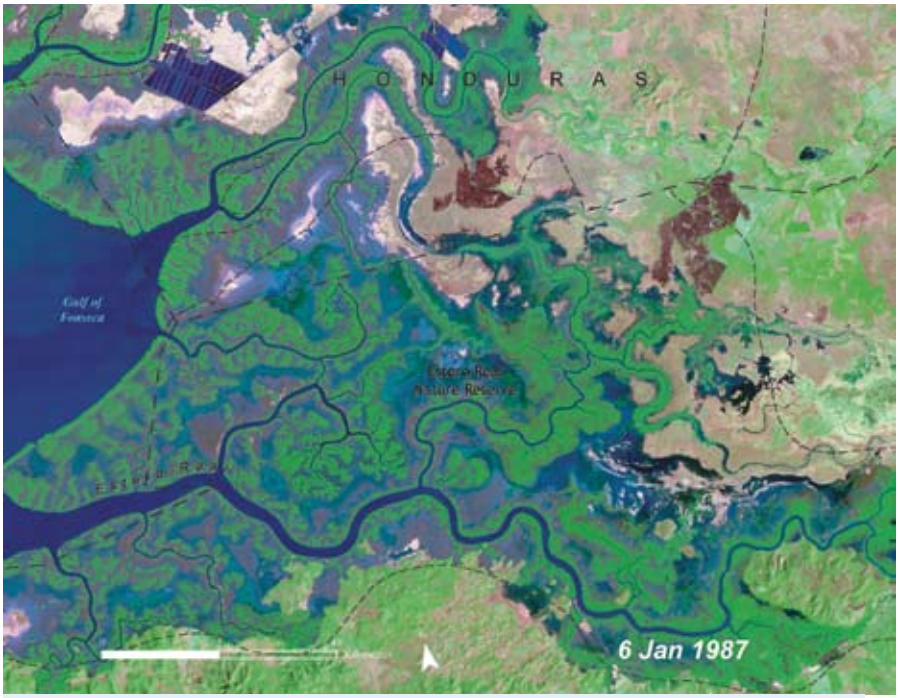
In addition, mitigation and preparedness activities were identified and implemented in the community. A public awareness campaign was used to inform people of simple household measures they could employ to prepare for annual flooding.

Demonstration homesteads were made flood-resistant using the technique of homestead-raising with financial assistance from the project and community contributions. To date, this project has been replicated in four more municipalities around northern Bangladesh. Other organizations also promote and support the use of this indigenous technique in Bangladesh.

6 Protect and value ecosystem services

Ecological conditions not only modify the frequency and magnitude of hazard events, but also affect natural barriers that can moderate the impacts of a disaster and protect communities. Moreover, maintaining ecosystems to decrease disaster risk can also contribute to the reduction of greenhouse gases and thereby further minimize the risk of future hazard events. Finally, ecosystems managed to support sustainable livelihoods also help to lessen the social, economic and environmental impacts of disasters on communities. Investments in ecosystems can therefore lead to significant savings, as compared to the cost of a disaster on human livelihoods.

The proliferation of new technologies and processes for managing natural resources, including new knowledge of the ecological, social and cultural dimensions of resource management, presents many opportunities for reducing disaster risk.



NASA / STILL PICTURES / UNEP

An image of aquaculture in the Gulf of Fonesca, Honduras. The conversion of mangrove forests to aquaculture illustrates the trade-off between ecosystems' protection function and the pressure of development.

The science of hazards

In January 2005, the International Council for Science launched an initiative to develop programmes on natural and human induced hazards. The council's statement calls for new research in the areas of :

- integrated research on the impacts of natural disasters on social and ecological systems;
- agreement on the an international global observation framework for the collection, management and open sharing of data and information on natural hazards;
- mapping of known exposures of human populations, resources and economic activities to multiple disasters;
- integrated models that combine geophysical, ecological, demographic and economic aspects of disaster scenarios;
- building of indigenous scientific and technical capacity in vulnerable regions to take advantage of existing knowledge and stimulate local innovation; and
- dissemination of the relevant results to policymakers and the public.

Valuing ecosystem services[14]

While the degree of protection provided by ecosystems depends on a number of factors, social and natural scientists have been working to calculate the 'prevention dividend' of protecting ecosystems services. Consider the following examples:

- A study of the value of conserving upland forests that form the watershed for the Vohitra river in eastern Madagascar estimated the net present value (NPV) of protection benefits at USD 126,700. This value is derived from the reduced costs of flooding and the increased net market value when less paddy is damaged by flooding[15].

- Sri Lanka's Muthurajawela marsh, a coastal peat bog covering some 3,100 ha, plays an important part in local flood control. The marsh significantly buffers floodwaters from the Dandugam Oya, Kala Oya and Kelani Ganga rivers and discharges them slowly into the sea. The annual value of these services was estimated at more than USD 5 million, or USD 1,750 per hectare of wetland area[16].

- Shoreline stabilization is also important for inland rivers. In the eastern United Kingdom, the cost of the loss of vegetation along riverbanks was estimated at USD 425 per metre of bank. This is the cost of maintaining artificial bank reinforcement to prevent erosion[17].

- In Indonesia, the value of coastal protection afforded by intact mangrove forest is estimated at up to USD 1 million per kilometre[18].

Upland forests and watersheds: The significant role of forest degradation in the impact of Hurricane Jeanne in Haiti gained widespread media attention and raised public awareness of deforestation as a disaster risk factor. Watershed management efforts, the most successful of which involve forest communities and include provisions for sustaining local livelihoods, are widespread around the world. Forest management also plays an important role in reducing the risk of devastating wildland fires. Indonesia, Malaysia, China, Russia, Canada and the US have all improved their forest management techniques, for example by minimizing debris on the forest floor to reduce fire risk.

Wetlands: Wetlands function as natural sponges that trap and slowly release surface water, rain, snowmelt, groundwater and floodwaters. Saturated wetlands lose this ability, so maintaining them is vital. In 2005, contracting Parties to the Ramsar Convention on Wetlands issued a new statement on the role of the Convention in disaster prevention, mitigation and adaptation. Among other points, the Convention encouraged its contracting Parties to ensure that wetland ecosystems are managed in such a way as to mitigate the impacts of hazards, for example by impeding floodwaters and tidal surges and providing



Flooding in the Sambava District of Madagascar. The 2006-2007 cyclone season in Madagascar has been particularly severe, affecting around one million people.

resilience against drought in arid and semi-arid zones. In the US, the Coastal America Initiative illustrates how government, private sector and other partners can join together to support broad-ranging wetland management efforts.

Coastal forests: There are many examples of coastal forests protecting communities from hazards. In Vietnam, the Red Cross has worked closely with local communities to restore coastal forests as protection against tropical storms. While there is conflicting evidence regarding the role of mangroves in protecting communities against the 2004 Indian Ocean tsunami, it is generally accepted that they provide critical protection against tsunamis of lesser magnitude, storm surges and coastal flooding[19]. In September 2006, the World Conservation Union, with support from the UN Special Envoy for tsunami recovery, President Bill Clinton, launched the landmark 'Mangroves for the Future' initiative to restore and conserve mangrove forests throughout the tsunami-affected areas.

Disaster mitigation: planting mangroves in Vietnam[20]

Vietnam is one of the most typhoon-struck countries in Asia, and the Vietnamese Red Cross is working on disaster mitigation strategies that reduce the vulnerability to the impacts of typhoons of people living and working in the Red River delta – an extensive rice-growing area in northern Vietnam and one of the most densely populated regions in the world.

The mudflats of the delta were claimed for agriculture over several centuries by building dykes. Local communities traditionally left a band of natural saltwater-tolerant mangrove forest between the dykes and the sea in order to help protect the rice fields from waves, wind and typhoon damage. However, the cutting of the mangrove forests for fuel and the spraying of chemical defoliants during the war in the 1970s destroyed most of this natural protection belt. As a result, some of the dykes started to erode, posing an increasing risk to people and their rice fields.

The government and several NGOs campaigned to reforest the coastline and with the support of the International Federation, the Japanese Red Cross Society and the Danish Red Cross, the Vietnamese Red Cross planted more than 175 km^2 of mangrove forest along almost 200 km of coastline, representing nearly the entire coastline (where natural conditions allowed). Local communities carried out the planting and were granted the right to harvest marine products such as crabs and mussels in the areas they had planted for a number of years.

Now that most of the planting has been completed, the Red Cross is focusing its efforts on dyke maintenance, applying other techniques to inland river dykes and developing new activities to support vulnerable people in the area

The benefits of the project are significant. In financial terms alone, this mangrove project proves that preparedness and mitigation pay. Indeed, the planting and protection of 12,000 ha of mangroves cost around USD 1.1 million, but helped reduce the cost of dyke maintenance by USD 7.3 million a year. The Red Cross also estimates that 7,750 families improved their livelihoods, and hence their resilience to further hazards, through the selling of crabs, shrimps and molluscs.



© AP / NASA

A photo taken on 18 November 2006 from the International Space Station shows New Orleans, USA. Sunglint accentuates the wetland setting by highlighting the numerous lakes, ponds, and rivers surrounding the city. Healthy wetlands perform the important functions of water quality control, absorption of flood waters and providing habitats for plant and animal species.

7 Consider environmental technologies and designs for structural defences

Communities around the world are protected from floods and storms by engineered structural defences. While the efficacy of these structures is at times questioned – particularly when they result in negative consequences downstream – and their environmental impacts can be dramatic, affecting coastal or riparian environments, fisheries and natural processes of erosion and sedimentation, they are and will continue to be a significant component of disaster prevention.

In recent years greater attention has been paid to using environmentally informed alternatives. At the World Conference for Disaster Reduction in 2005, the Government of Japan, for instance, is shifting from flood protection based on concrete river walls to construction based on ecosystem restoration. In Sri Lanka, the Disaster Management Centre has studied the potential benefits of adopting hybrid schemes or 'soft engineering' approaches to coastal defence. In the US, community members in California, having rejected several environmentally insensitive flood plans, opted for an innovative combination of bank terracing, parkland bypass channels, and restoration of downstream tidal wetlands. Also in the US, the Department of Natural Resources is working with other

partners to manage sand resources against sea-level rise. Similarly, in the Maldives, structural measures to reclaim land from the sea are being re-evaluated in light of the effects such modifications have on the ability of island ecosystems to naturally adapt to rising sea levels.

Environmental authorities play an important role not only in drawing attention to the environmental impacts of structural defences but also, where appropriate, advocating for environmental technologies.

8 Integrate environmental and disaster risk considerations in spatial planning

Spatial planning is an important tool for integrating environment and disaster considerations into development plans. Multi-sectoral development-oriented zoning enables governments and other stakeholders to assess possible land-use options for different areas and to choose the best options on the basis of possibilities, limitations and values. Environmental authorities, who provide the environmental information and analyses fundamental to spatial planning, have promoted spatial planning as a means of preventing further environmental degradation and protecting ecosystems.



STILL PICTURES / UNEP – LEE CHUI YEE

New settlements can be safer and more sustainable if environment and disaster management considerations are integrated in development planning.

Environmental data, however needs, to be linked with socio-economic information to support a multi-stakeholder dialogue in areas with several possible competing uses. Likewise, data on the physical attributes of hazard risk should be linked to information on the distribution of the socio-economic characteristics of vulnerability. In addition, the risk reduction capability of environmental features must be taken into account when ascribing value to ecosystem services.

While spatial planning is an asset in any location where development is anticipated or in progress, it is absolutely necessary in coastal zones because of their extreme sensitivity and because well-established mechanisms for integrated coastal zone management represent points of entry through which disaster risk and environment can be systematically considered. Strengthening integrated coastal zone management through spatial planning capacity should be paired with strengthening political commitment and capacity for enforcing zoning regulations.

Poverty contributes to both environmental degradation and vulnerability to hazards and should be addressed accordingly. Measures to reduce poverty include agricultural expansion, which may require wetlands to be filled, and activities in coastal areas, such as shrimp farming, that considerably degrade the environment or change the entire ecosystem. It is therefore vital that the causal link between development, disasters and environmental degradation is recognized in poverty-reduction activities.

9 Prepare for environmental emergencies

Environmental emergencies are defined as the uncontrolled, unplanned or accidental release of a substance into the environment that may affect human life or health or the environment on which human health depends. Such emergencies include those resulting from human activities as well as ones created as a side effect of a natural hazard. Preparing for environmental emergencies requires information on underlying vulnerabilities, knowledge of risks, proper risk communication, and community stakeholder engagement.

Information on the hazards involved in the industrial operations in the vicinity needs to be provided to the concerned members of the community, and measures should be taken to reduce these risks. Emergency response plans should be established and regularly reviewed and updated. Local industry involvement in community awareness and emergency response planning is vital for community engagement in emergency preparedness.



STILL PICTURES / UNEP – M. ROUGIER

Fire fighters protect neighbouring communities in their response to a forest fire in France.

The integration of industry emergency plans with local emergency response plans into one overall community plan to handle all types of emergencies is the basis of a multi-hazard multi-stakeholder approach to emergency preparedness. In this respect, it is of the utmost importance to promote the involvement of all members of the community in the development, testing and implementation of the overall emergency response plan, promoting awareness of the underlying risks, and plan ownership.

10 Strengthen capacities for environmental recovery

Recovery and reconstruction efforts that are carried out without proper environmental guidance and safeguards can have devastating short- and long-term impacts on the environment. The environmental footprint of post-disaster recovery can be significant. The scramble to make ends meet and rise 'from the ashes', in particular, involves intensive exploitation of the remaining natural resources[21], both on site and in the remaining non-affected locations.

Such activities are not only unsustainable from the point of view of those affected by disasters – resources are limited and do not offer a long-term solution to their dilemma – they are also unsustainable from an environmental perspective.

Governments and organizations are often ill-equipped and ill-prepared to carry out even rapid environmental impact assessments (EIAs) in resettlement areas, and can be overwhelmed with the number of development projects to evaluate. However, adverse consequences are potentially avoidable with a solid response and recovery framework in place before a disaster strikes.

Strategic Environmental Framework[22]

The Strategic Environmental Framework (SEF) for a More Environmentally Sound Reconstruction of Aceh Province in Indonesia is a set of policies, structures and operational guidelines ensuring that environment is properly considered in Aceh's complete reconstruction programme and project cycle – from policy development to planning, implementation, monitoring, and compliance promotion. The objectives include supporting environmentally and socially sound investments; ensuring that environmental and social aspects, including cumulative impacts, are considered at an early stage in the reconstruction planning process; and preventing inadequate implementation of environmentally sound plans and projects. The SEF is designed to assist decision-making in the project cycle's early stages and to provide a practical tool for mitigating project impacts. The framework proposes a series of interventions that can be used independently or as a whole.

Endnotes

1 The Working Group on Environment and Disaster Risk Reduction was established by the former Inter-Agency Task Force for Disaster Reduction (IATF/DR). With the aim of advocating for more authoritative understanding of the two-way linkages between environment and disaster risk reduction, from the scientific and policy perspectives and responding to requests for guidance on related issues from the ISDR System.

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Opportunities for Environment in Disaster Risk Reduction

1. Engage environmental managers fully in national disaster risk management mechanisms:
National platforms for disaster risk reduction should integrate environmental concerns and should be supported by environment-related institutions. Likewise, disaster managers are important partners in environmental management initiatives.

2. Include risk reduction criteria in environmental regulatory frameworks:
Frameworks such as Environmental Impacts Assessments and Strategic Environmental Assessments, which have been successfully used to prevent further environmental degradation, should be adapted to address disaster risk as well.

3. Assess environmental change as a parameter of risk:
Risk assessments form the basis of risk reduction strategies and preparedness planning, and should also be the foundation for development plans at the national or the community level. Environmental change should be factored in as a parameter of risk.

4. Utilize local knowledge in community-based disaster risk management:
The indigenous knowledge of people who live in hazard-prone areas should be considered as complementary to scientific knowledge in the development of community-based disaster risk management plans and programmes.

5. Engage the scientific community to promote environmental research and innovation:
Greater interaction between policymakers, environmental managers and the scientific community can breed familiarity with technological alternatives and innovations and stimulate targeted research towards reducing disaster risk.

6. Protect and value ecosystem services:
The proliferation of new technologies and processes for managing natural resources, including new knowledge of the ecological, social and cultural dimensions of resource management, presents many opportunities for reducing disaster risk.

7. Consider environmental technologies and designs for structural defences:
While many communities around the world are protected from hazard risks by engineered structural defences, greater attention to environmentally-sound designs could simultaneously help protect them from environmental degradation.

8. Integrate environmental and disaster risk considerations in spatial planning:
Environmental authorities, who provide fundamental information and analyses during multi-sectoral zoning and land-use planning, should advocate for greater attention to disaster risk reduction during these processes.

9. Prepare for environmental emergencies:
Preparing for environmental emergencies requires communication, engagement of community stakeholders and information on underlying vulnerabilities.

10. Strengthen capacities for environmental recovery:
Recovery, reconstruction and risk reduction efforts must be carried out with proper environmental guidance and safeguards to avoid devastating short- and long-term impacts on the environment.

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