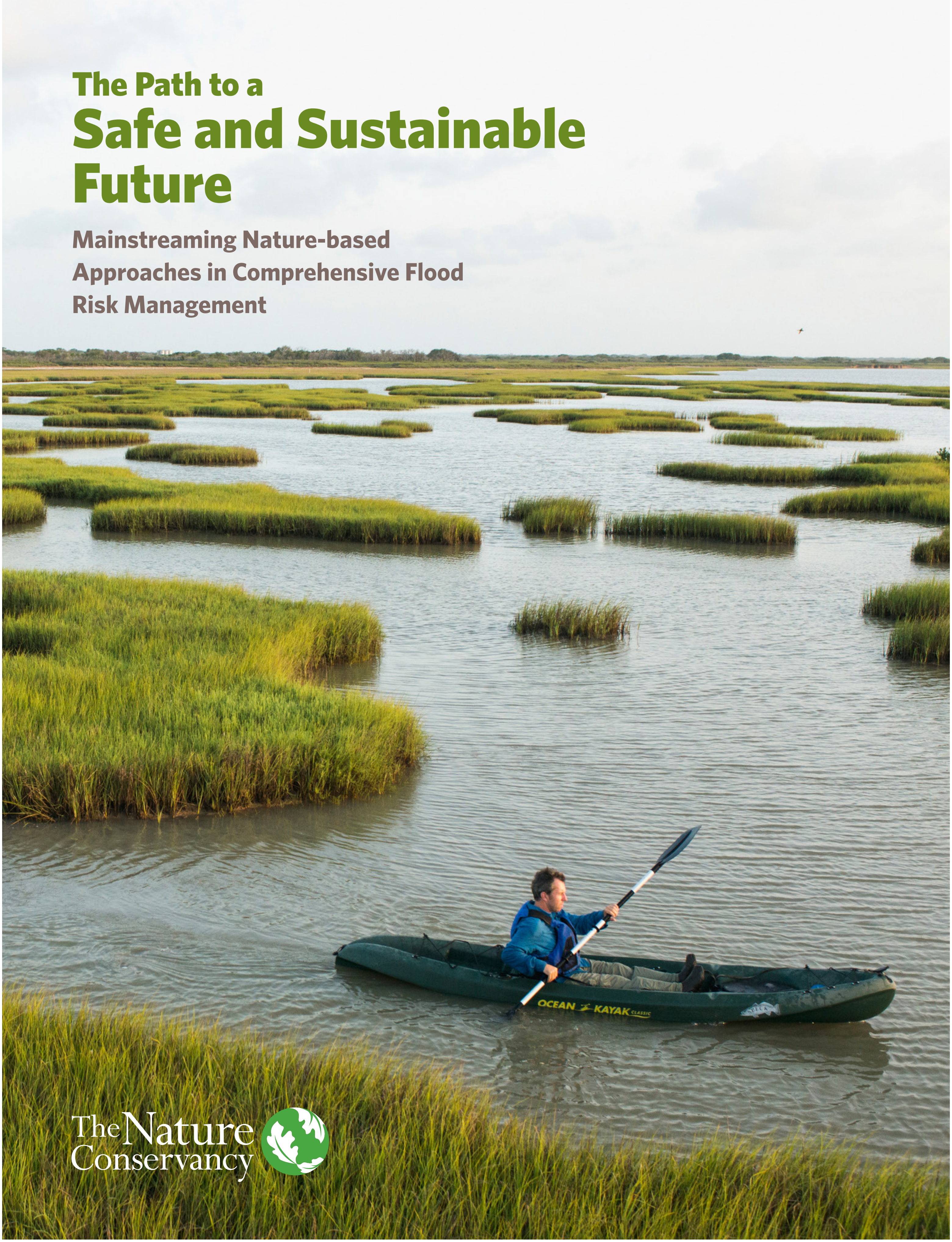
The Path to a Safe and Sustainable Future

Mainstreaming Nature-based Approaches in Comprehensive Flood Risk Management



The Nature Conservancy

The Path to a Safe and Sustainable Future:

Mainstreaming Nature-based Approaches in Comprehensive Flood Risk Management

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The Nature Conservancy

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COVER IMAGE: Carlton Ward Jr.

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Executive Summary

Water-related disasters -- floods and storms -- are the most frequent and economically and socially destructive of all natural disasters.[1] The increasing frequency, severity and costs of floods and storms are a major threat to the safety of people around the world and are a brake on the pace of development of people and countries around the globe.

Between 1994-2013, natural disasters have affected 4.3 billion people worldwide – of which, 3.0 billion people were negatively affected by floods and storms.[2] In addition, these floods and storms caused $1.6 trillion (USD) of damage.[3] Natural disasters and the efforts to recover from disasters are also a significant counterweight on economic and social development at national and regional levels. For every 1% increase in the area impacted by floods there is a 1.8% reduction in economic growth in a given year, with additional effects lingering into following years.[4]

The trends related to environmental degradation are similarly stark. Global biodiversity continues to decline among all taxa, with freshwater and marine species among those with the most rapid declines.[5] The population of freshwater species have declined by 76% over the past 40 years.[6] The world has effectively lost 19% of the original area of coral reefs and 20% are under threat of loss in the next 20-40 years.[7] Coastal systems are similarly widely degraded. Between 20% and 35% of mangrove areas around the world have been lost since 1980.

The increase in storms is fuelled by the changing climate and damages they inflict are exacerbated by the continued degradation of the environment. Healthy ecosystems play an important role in naturally defending lands from the impacts of storms and floods.

Today, nations are aligning to two key global agreements: the United Nations 2015 Global Goals for Sustainable Development (SDGs) and the 2015 Conference of Parties Paris Agreement . Both of these explicitly recognize and address the increased disaster risk and the threat from environmental degradation -- and both call for action to address them directly.

Two strategies are uniquely able help countries achieve the SDGs and the Paris Agreement . The first is the need to sustain a focus on and increase investments in comprehensive flood risk management at national, regional and local scales. Currently, less than 1/2 of 1 percent of the overall investment in development is spent to prevent the disasters that cost almost as much as has the total amount that has been invested in promoting development over the last 40 years.[8]

Second is the need to consistently include nature-based approaches as an integral part of sustainable development broadly and, in particular, as an integral part of comprehensive flood risk management. Development projects of all types, and in particular flood risk management efforts, should include environmental protection and restoration as explicit project outcomes. Increased investment in these two strategies is critical.

Nature-based approaches are the intentional use, protection and restoration of the natural features and of natural functions as integral part of addressing human needs. Nature-based approaches include the protection and restoration of natural systems as an explicit desired project outcome.

Comprehensive flood risk management is the adaptive process of planning and implementing a portfolio of risk reduction measures based on the relative amount of risk.

The path to a safe and sustainable future integrating nature-based approaches into each of the phases of the flood risk management cycle. Ensuring the environmental goals are included at the outset as a key desired outcome of risk management will help ensure strategies are developed which both sustain environmental resources and reduce risks. Integrating nature-based approaches into the flood-risk management cycle will help ensure a full portfolio of approaches and projects, including traditional, nature-based, and combinations of both, are considered and deployed.

Figure 1: Ecosystems in the flood risk management cycle.[9,10]

To more consistently advance these strategies, there is the need to identify and commit to explicit goals related to their consistent use and deployment. Specifically, at the global level there should be efforts to:

- Set targets for increased investment in pre-disaster mitigation planning and projects;
- Set targets for increased investment in nature-based approaches through public and private plans and projects;
- Support improved national policies related to flood risk management and use of nature-based approaches;
- Invest in science and the sharing of information related to comprehensive flood risk management and the use of nature based approaches;
- Broaden education and outreach

The SDGs and the commitments arising from the Paris agreement provide the opportunity and framework within which nations and communities can fully embrace both comprehensive flood risk management and the use of nature-based approaches.

Setting the Scene

Introduction

The most widespread and costly natural disasters are those that result from floods and storms.[11] The increasing frequency, severity and costs of floods and storms are a major threat to the safety of people around the world and are a brake on the pace of development of people and countries around the globe. The increase in storms is fuelled by the changing climate and damages they inflict are exacerbated by the continued degradation of the environment. Healthy ecosystems play an important role in naturally defending lands from the impacts of storms and floods. Combined with continued population growth, the migration of people to cities, and an increasing standard of living around the world, the costs of these disasters, in both human and economic terms, will continue to grow and will slow the progress of global development and the extraction of billions of people from poverty

Simultaneously, environmental conditions continue to degrade around the world. The growing global population and the rising standard of living in many parts of the world are accelerating the use and exploitation of the earth's resources, destroying and altering habitat areas and disrupting the natural processes on which species and ecosystems depend. As a result, global biodiversity continues to decline among all taxa, with freshwater and marine species among those with the most rapid declines.[12] The loss of freshwater and coastal ecosystems increases the risks to people, property and livelihoods from floods and storms.

Today, nations around the world, and the multi-lateral and bi-lateral groups supporting these countries, are aligning most of efforts to two key global agreements: the 2015 Global Sustainability Goals and the 2015 Conference of Parties (COP21) climate agreement Both recognize and address the increased disaster risk and the threat from environmental degradation -- and both call for action to address them directly.

The SDGs prominently mention the need to address extreme events and disasters in 4 of the 17 goals[1]. In addition, the SDGs explicitly focus on the need to reverse the tide on environmental degradation in 3 of the 17 goals.[2]

Similarly, the Paris agreement on climate change focuses attention on the need to adapt to changes brought on by climate change and recognizes:

> "*the importance of averting, minimizing and addressing loss and damage associated with the adverse effects of climate change, including extreme weather events and slow onset events, and the role of sustainable development in reducing the risk of loss and damage.*" [13]

And it highlights

> "*the importance of ensuring the integrity of all ecosystems, including oceans, and the protection of biodiversity, recognized by some cultures as Mother Earth, and noting the importance for some of the concept of "climate justice", when taking action to address climate change.*" [14]

Two strategies are uniquely able to play a major role achieving the SDGs and Paris Agreement related to flood risk reduction and environmental sustainability. First is the need to increase attention and investments in the comprehensive flood risk management at national, regional and local scales. Second is the need to consistently include nature-based approaches as an integral part of achieving sustainable development broadly and, in particular, as integral to holistic flood risk management.

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1 Goal 1 (ending poverty), Goal 9 (building resilient infrastructure), Goal 11 (cities and human settlements), and Goal 13 (action to combat climate change)

2 Goal 6 (water), Goal 14 (oceans), and Goal 15 (terrestrial systems). Resolution adopted by the General Assembly on 25 September 2015, 70/1. Transforming our world: the 2030 Agenda for Sustainable Development, pp. 6, 23, & 24.

TNC: David Y. Lee

In particular, there is a great need to shift the focus of risk-reduction investments from post-disaster recovery to greater investment in pre-disaster preparation and mitigation. Such pre-disaster investments reduce risks through the use of a portfolio of risk management approaches and support the development of plans that outline how to 'build back better' when a disaster does occur.

Similarly, there is the need to greatly increase the investments to reverse environmental degradation, particularly the continuing degradation of coastal and river ecosystems. The consistent use of nature based approaches to flood risk management is an important part of reversing these trends. By including the protection and restoration of key habitats such as reefs, marshes, and floodplains as key elements of flood risk management nations will be investing in both reducing disaster risk and contributing to the economic and social well-being of communities and nations.

Disaster risk management and environmental sustainability are two key tools that will permit nations and communities – both developed and developing - to build a clear path to a safe and sustainable future.

Today, with the focus firmly on implementing the Sustainable Development Goals and implementing theParis commitments, it becomes more apparent that comprehensive flood risk management and environmental sustainability are critical to meeting achieving these shared goals and commitments. These new imperatives provide the opportunity to turn the existing recognition of the need to build disaster risk management and environmental sustainability into the core efforts of global and national development goals. Integrating the adoption of these approaches in to all phases of development and investment will accelerate improvements in the quality of the lives of the poorest and reverse the trends of environmental degradation.

Scale and Scope of Flood and Storm Risk

Water-related disasters -- floods and storms -- are the most frequent and economically and socially destructive of all natural disasters. From 1994-2013, natural disasters have affected 4.3 billion people, 3.0 billion of which were caused by floods and storms.[15] These floods and storms caused USD $1.6 trillion of damage.[16] Over the last three decades, these events have become more frequent and costly.[17] Munich Re, the global reinsurance firm, estimates that total financial losses due to natural hazards averaged $190 billion[18] per year over the 10 year period of 2005-2014. Over the 20 years from 1995 to 2015, 71% of all disaster events were caused by flood and storms.[19] As shown in the 2016 World Risk Report (Figure 1) the number and costs of all disasters, and those associated with floods and storms, continue to increase.[20]

Natural disasters and the subsequent response to recover from disasters are also a significant counterweight on economic and social development at national and regional levels. For every 1% increase in the area impacted by floods there is a 1.8% reduction in economic growth in a given year, with additional effects lingering into following years.[21] For example, countries affected by tropical cyclones experience lower GDP growth in the following 15 years from the event.

This has a direct impact on national and regional development. As reported in the UN Water report A Post 2015 Global Goal for Water,[23,24] "since 1980, the risk of economic loss due to floods has increased by over 160% and to tropical cyclones by 265% in OECD countries. In fact, economic loss risk to floods and cyclones in OECD countries is growing faster than GDP per capita." Through sea level rise and changes in the frequency and intensity of storms, climate change will continue to drive increases in flood and storm damages.

Figure 1: Number of Reported Disasters and the Amount of Damages[25]

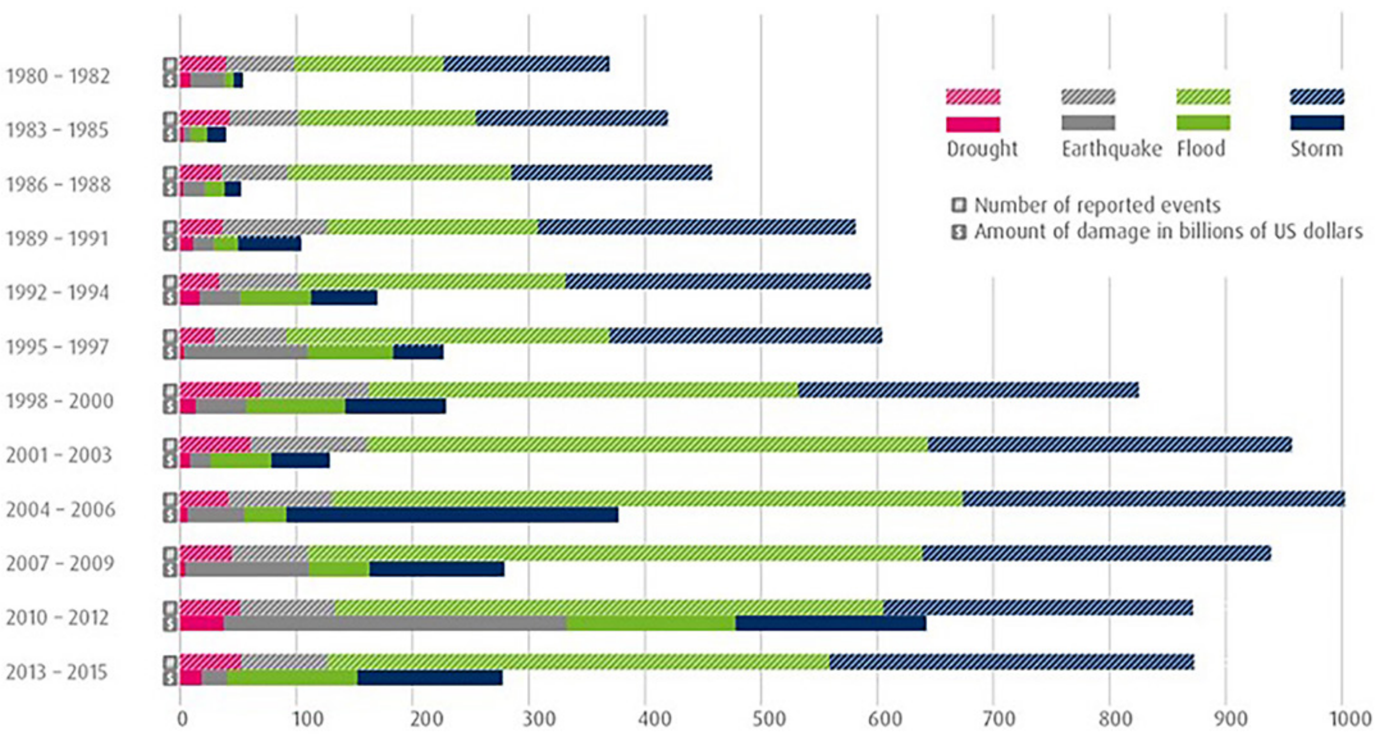

Figure 1: Number of reported disasters and the amount of damages
(Sources: EM-DAT, The OFDA/CRED International Disaster Database)

Scale and Scope of Environmental Degradation

The trend of environmental degradation of coastal and freshwater environmental resources is similarly negative. The population of freshwater species have declined by 76% over the past 40 years.[26] Wetlands have been particularly degraded, with 64-71% of all wetlands being lost since during the 20th century.[27] IUCN's red list species – those most at risk of extinction, show similar stresses, stating "that overall, wetland species are increasingly moving towards extinction in these groups, and that conservation successes are being increasingly outweighed by worsening pressures."[28]

Coastal systems are similarly widely degraded. Between 20% and 35% of mangrove areas around the world have been lost since 1980. Mangrove areas continue to disappear – with estimates of loss as high as 2–8% per year.[29] The primary reasons for these declines include their over-exploitation for fuel wood and timber production and the clearing of mangroves for aquaculture, especially for cultivation of shrimp.

Coral reefs are also under threat. According to the 2008 report on the status of coral reefs, the world has effectively lost 19% of the original area of coral reefs and 20% are under threat of loss in the next 20-40 years.[30] Climate change and the associated warming water and ocean acidification put reefs further at risk.

The loss and degradation of these resources also increase the risks associated with floods and storms. Wetlands, floodplains and riparian forests all play a role in slowing floodwaters, improving infiltration, and increasing transpiration through plants. Loss of coastal reefs, marshes and mangrove forests also increase risks from waves and storm surges. Similarly, loss of upland forest areas can increase flood intensity, increase erosion and related landslide risks, and reduce infiltration of water into soils and groundwater.[31]

Structural Flood Defenses Measures as a Cause of Environmental Degradation

Flood control efforts and environmental degradation are often strongly connected because flood control structures, such as levees, dams and seawalls, often have severe negative impacts on natural habitats and natural processes and therefore can have severe impacts on biodiversity and environmental health. There are two primary causes of these negative impacts: first, by design and purpose, these structures disrupt and displace natural processes, such as the movement of water, needed to support ecosystems and biodiversity. Water movement is the primary driver of freshwater and coastal systems and the biodiversity these systems support. Floods and storms are also a critical part of the natural disturbance regimes necessary for the health and sustainability of these systems.

Second, flood control structures are generally built in, on and near coastal and river. The footprint of these structures often directly destroys key habitat areas such as wetlands, floodplains, marshes and intertidal zones. So, between direct habitat loss and disruption of natural processes, traditional efforts to control floods can be a significant cause of the degradation of these systems. Table 1 summarizes some of these impacts.

Table 1: Impacts of Flood Management Structures on the Environment[32]

STRUCTURE	IMPACTS ON THE ENVIRONMENT
RIVER SYSTEMS	
Dams	» River species largely replaced by lake species in reservoir » Rivers species dependent on natural flow regime downstream will be diminished or disappear » River species needing to access upstream or downstream habitats may diminish or disappear » Releases of cold, clear water from deep water of the reservoir changes temperature regime and primary production downstream » Downstream, floodplain structure, function, and biodiversity is changed, as flooding is reduced or eliminated.

Levees and Embankments	» Loss of connectivity between river and flood plain, including loss of habitat creation associated with disturbance regimes » Loss of exchange of nutrients, carbon, silt and sediments with floodplain » Loss of pool and riffle patterns and other heterogeneities in channel form » Loss of input of organic material from riparian areas » Loss of floodplain foraging, refuges and spawning areas for river species » Loss of floodplain forests (timber, fruits, medicines)
River Channelization	» Loss of river habitat diversity, including backwaters and refuges; loss of native river species » Loss of channel form heterogeneity, including loss of in-stream and riparian vegetation » Lowering of floodplain groundwater tables, affecting riparian vegetation and floodplain wetlands » Increased channel depth, slope and flow velocity leading to increased flooding, bank and bed erosion and likely sedimentation problems downstream » Reduction in nutrient and pollution assimilation capacity of river channel
COASTAL SYSTEMS	
Bulkheads, seawalls and revetments	» Loss of shoreline habitat diversity, including beaches, dunes, marshes, mudflats, with loss of associated species » Loss of benthic habitats and nearshore vegetation, including erosion of foreshore » Erosion of neighbouring shorelines » May impede littoral movement and migration of some species » Loss of sediment and littoral inputs from shore may change form and functions of estuaries and shorelines
Jetties and Breakwaters	» Changes in wave energy, water circulation, and water residence times, can increase eutrophication and other water quality issues » Changes in erosion and deposition patterns of sand, sediments and silt » Changes in flows, including river outlet flows » Footprint of structure may change soft bottom habitat into hard bottom habitats
Groins	» Block littoral drift of materials and species along shoreline » Changes of beach or shoreline slope and shape » Loss of tidal flats » Downdrift erosion problems » Footprint of structure may change soft bottom habitat into hard bottom habitats

Trends and Drivers

The threat posed from floods and storms and the degradation of the environment are both long-standing and well-recognized problems. The need to address these issues have been recognized and called for in many global and multi-national agreements over the past three decades (see Appendix 2). Yet despite the numerous agreements and supporting documents, progress remains slow, as discussed in the 2015 Global Assessment Report on Disaster Risk Reduction.[33] In addition, these threats are predicted to continue to worsen as the result of a number of drivers and trends that exist at the global scale – yet touch down in almost every nation.

Climate Change: The global temperature increase of .8 degrees Celsius since the start of the industrial revolution has been enough to drive changes in the frequency and strength of floods and storms and to increased sea level rise.[34] Such changes are expected to continue to increase even if the global goal of limiting these increases to 1.5-2.0 degrees Celsius is achieved. Warming temperatures will also hasten many aspects of environmental degradation – including direct threat to species, changing of habitat conditions, including ocean acidification and changing of hydrologic cycles on which many species depend.


TNC: Juan Arredondo

Population Growth: The global population in 2015 was estimated at 7.4 billion people. The number of people is projected to increase to 8.1 billion by 2050 and to 11.2 billion by 2050.[35] Many of these people will live in medium and high hazard areas along rivers and coasts where they will be at risk of a flood and storm related disasters.[36] The large number of people will also require more resources and drive further land use changes that will continue to degrade the environment.

Urbanization: The percentage of the world's population living in urban areas has increased from 746 million in 1950 to 3.9 billion in 2014. An additional 2.5 billion people are expected to be living in urban areas by 2050.[37] Many major cities are located along highly populated coasts and in riverine areas and deltas, which are often low-lying and vulnerable to flooding.[38] Cities will also exacerbate environmental degradation through the land use change associated with growing urban areas and the resources needed to sustain these population centers.

Increasing Standard of Living: Increasing global wealth is one of the great achievements of the late 20th and early 21st century – but this increased wealth also equates to the fact that the value of property losses from floods and storms is greater. Global household wealth has more than doubled since 2000 with the global average per adult wealth standing at $56,000 USD in 2014. There are great disparities across the various regions of the world, but all regions have some growth in wealth over this time period.[39] Wealth can also lead to greater environmental degradation as more people have the means to afford higher quality and more foods, products and materials – the production of which can lead to environmental degradation.

Aging Infrastructure: Aging and antiquated infrastructure can increase flood and storm risks. Levees, dikes and seawalls need regular inspections, periodic maintenance and upgrades. Lack of sufficient investment can lead to loss of structural integrity with resulting increased risk and potential catastrophic failure. Designs not based on current engineering standards or without understanding of flood risk management can also increase risks from floods and storms. In addition, much older infrastructure was built prior to a full understanding of environmental issues and national environmental assessment and management programs. They may be designed and operated in ways that unnecessarily degrade the environment.

Global Response to Disasters

The current investment in disaster prevention and response is tiny when compared to both the cost of disasters and when compared to the amount of development aid that has been invested globally. Over the last two decades, over $3 trillion has been spent on development projects and programs.[40] Yet, over a similar time period, disasters have cost nearly $2.5 trillion in damages, lost productivity and reconstruction efforts.[41] As noted above, floods and storms are the most devastating of all natural disasters.

Despite the huge cost of disasters and the resulting impact on economic and social development, only about 3.5% ($106 billion) of total global development assistance over 20 years from 1990-2010 was allocated for disaster-related activities, as reported by the Global Facility for Disaster Risk Reduction (GFDRR). Of this $106 billion, only 12.7% ($13.5 billion) was directed to efforts that mitigate and proactively take actions designed to cut long term disaster losses.[42]

Stated in another way, about 65% of the funding for natural disasters was spent on emergency response with another 22% funding reconstruction and rehabilitation after disasters strike. Less than 1/2 of 1 percent of the overall investment in development is spent to prevent the disasters that cost almost as much as has the total amount that has been invested in promoting development over the last 40 years.[43]

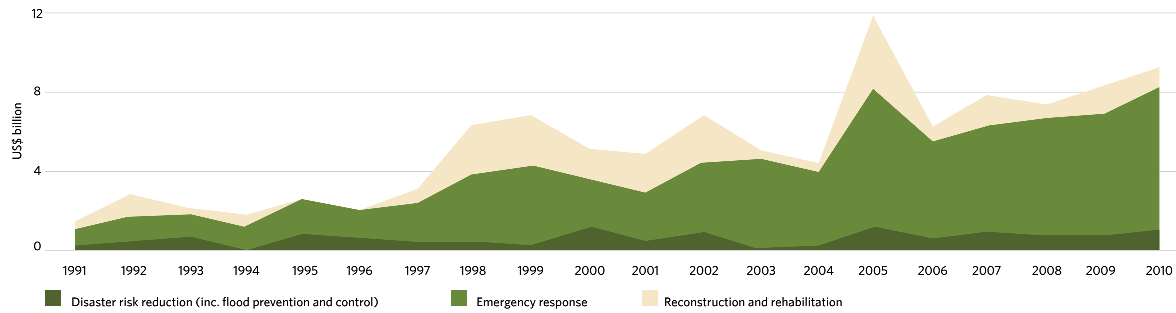

Figure 2: The Share of DRR in international aid for disaster, 1991-2010 (constant 2010 USD)[44]

Other analyses reveal a similar pattern of investment focused much more on disaster response than on pre-disaster mitigation. OECD/DAC examined funding levels and found that from 2007 to 2011 less than 20% of Development Assistance Committee (DAC) donor contributions to humanitarian assistance went to disaster related activities with under 5% going to disaster prevention and preparedness.[45] While less well documented, the consensus is national level funding targeted to reduce the impacts and damages from disasters – that is funding for pre-disaster mitigation -- is also largely missing.

Climate funds are increasing becoming a funding source for disaster risk reduction. Between 2003 and 2014, $2.1 billion of assistance came from climate change adaptation funds, of which, $369 million was focused on DRR activities[46] – or about 18% of the total. In addition, private investment in infrastructure is the largest share of overall infrastructure investments.[47] Over the next 10 years global infrastructure investment is expected to grow from $4 trillion to $9 trillion,[48] so how they are invested will have a major impact on disaster risk and environmental sustainability.

Yet, to date the investment in disaster risk reduction is not occurring at the scale that needs to happen. Jo Scheuer, a senior official at UNDP, has noted that disaster risk reduction is typically underfunded, misdirected and, as a result, inadequate and that "the international community is not targeting support where it is needed most, with little rhyme or reason as to where funds end up or what the long-term goals are." He also points out that "the little support is given to disaster risk reduction is often concentrated in only a handful of countries, mostly middle-income and not necessarily the most at-risk" and that "… these issues must be rectified if we are to protect lives and secure our development gains."

Doing the Right Thing: Mozambique:

Beginning in 2011, the Mozambique national government began to prioritize risk reduction in key areas, including structural flood protection measures (dams, settlement protection dikes and increased drainage in transportation infrastructure), as well as incipient measures directed toward a policy of integrated water and coastal management. Over 2012-2013, they increased their DRR commitment and allocated $58.7 million (4.97 percent of the federal budget). This represents a substantial financial commitment and positive trend toward national DRR activities.

In fact, over 2012-2013, Mozambique spent the majority of its DRR budget on prevention and reduction ($54.55 million, or 4.62 percent of its national budget); and over the same period, Mozambique allocated $4.17 million (0.35 percent of its national budget) to recovery and response funding. Moreover, federal reporting indicates that sub-federal provinces and districts have gradually implemented integrated disaster risk management into their budgets and plans, and by 2012-2013, these activities accounted for 8.4 percent of aggregate sub-federal budgets, a total of $28.25 million. Much of this activity has been supported by international, multilateral contributors in response to severe flooding events experienced over the past fifteen years.

Global Response to Environmental Degradation:

As described by UNEP, it is difficult to get a complete picture of the amount of resources invested in addressing environmental degradation and pollution.[49] What is tracked are the commitments in relation to UN conventions at the global scale. The Organisation for Economic Co-operation and Development (OECD) countries' aid commitments to the three UN conventions on biodiversity, climate and desertification grew from US$5.1 billion in 1999 to US$17.4 billion in 2009. The same countries allocated US$22.9 billion to official development assistance for climate change mitigation and adaptation in 2010.[50] This is just a fraction spent by national governments on environmental programs within their own countries.

The investment into the implementation of global conventions, while significant, are far less than the funds spent on disaster relief and far less than what is needed to address environmental degradation. For example, the cost for developing countries to adapt to climate change alone has been estimated at US$70–US$100 billion a year for 2010–2050.[51] Of this, about $12.6 -$44.6 is for coastal flood protection and $5.3-7 billion for river flood protection."[52]

TNC: Juan Arredondo

Charting a New Course

Meeting Sustainability and Climate Goals

Today, nations around the world and the multi-lateral and bi-lateral groups that support these countries appropriately align most of efforts to two key global agreements: The 2015 Global Sustainability Goals and the 2015 Conference of Parties Climate agreement. Both of these unprecedented agreements recognize importance of the increased disaster risk and the threat from environmental degradation to achieving the respective goals of the agreements -- and both call for action to address them directly.

The SDGs prominently mention the need to address extreme events and disasters in 4 of the 17 goals.[3] In addition, the SDGs explicitly focus on the need to reverse the tide on environmental degradation in 3 of the 17 goals.[4] Similarly, theParis agreement on climate change focuses attention on the need to adapt to changes brought on by climate change and recognizes

> *"the importance of averting, minimizing and addressing loss and damage associated with the adverse effects of climate change, including extreme weather events and slow onset events, and the role of sustainable development in reducing the risk of loss and damage."* [53]

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Comprehensive flood risk management is the adaptive process of planning and implementing a portfolio of risk reduction measures based on the relative amount of risk.

Nature-based approaches are the intentional use, protection and restoration of the natural features and of natural functions as integral part of addressing human needs. Nature-based approaches include the protection and restoration of natural systems as an explicit desired project outcome.

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3 Goal 1 (ending poverty), Goal 9 (building resilient infrastructure), Goal 11 (cities and human settlements), and Goal 13 (action to combat climate change). Resolution adopted by the General Assembly on 25 September 2015, 70/1. Transforming our world: the 2030 Agenda for Sustainable Development, pp. 6, 23, & 24.

4 Goal 6 (water), Goal 14 (oceans), and Goal 15 (terrestrial systems). Resolution adopted by the General Assembly on 25 September 2015, 70/1. Transforming our world: the 2030 Agenda for Sustainable Development, pp. 6, 23, & 24.

Sustainable Development Goals (SDGs)

Goal 1. End poverty in all its forms everywhere

Goal 2. End hunger, achieve food security and improved nutrition and promote sustainable agriculture

Goal 3. Ensure healthy lives and promote well-being for all at all ages

Goal 4. Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all

Goal 5. Achieve gender equality and empower all women and girls

Goal 6. Ensure availability and sustainable management of water and sanitation for all

Goal 7. Ensure access to affordable, reliable, sustainable and modern energy for all

Goal 8. Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all

Goal 9. Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation

Goal 10. Reduce inequality within and among countries

Goal 11. Make cities and human settlements inclusive, safe, resilient and sustainable

Goal 12. Ensure sustainable consumption and production patterns

Goal 13. Take urgent action to combat climate change and its impacts

Goal 14. Conserve and sustainably use the oceans, seas and marine resources for sustainable development

Goal 15. Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss

Goal 16. Promote peaceful and Inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels

Goal 17. Strengthen the means of implementation and revitalize the Global Partnership for Sustainable Development

Effectiveness of Comprehensive Flood Risk Management

Planning, preparedness and coordinated responses - including floodplain management, early warning systems and increased public awareness of risk - have been shown to greatly improve the resilience of communities to natural hazards. Blending structural and non-structural flood management approaches is particularly cost-effective. It is likely that the targets in this domain could be met with a modest strategic investment in preparedness which will greatly reduce costs for relief and recovery from disasters. Well-designed national public employment programs using local resource-based work methods can have a large multiplier effect on vulnerable communities by combining the multiple objectives of employment generation, income support, asset creation and restoring the natural resource base.

Two Strategies

Two strategies are integral to achieving the SDGs and meeting the commitments under COP21. The first is to advance the practice and investment in the comprehensive flood risk management at national, regional and local scales. The second is to consistently include nature-based approaches in public and private development activities broadly.

Comprehensive Flood Risk Management

There is a pressing need to shift the emphasis of investments from post-disaster recovery to greater investment in comprehensive flood risk management through pre-disaster preparation and risk mitigation activities. Such pre-disaster investments reduce risks through the use of a portfolio of risk management approaches and support the development of plans that outline how to 'build back better' when a disaster does occur. Effective flood risk management requires a comprehensive approach that focuses on identifying and addressing the issues and areas of highest risk.

Many aspects of comprehensive flood risk management are not new. People have been coping with flooding since the beginning of civilization. People who occupied or traversed floodplains millennia ago understood the easiest way to avoid the onslaught of rising water was to move to higher ground. The solution was to move out of the way when a flood was coming.

Yet, as more permanent communities developed and agriculture flourished, floods were increasingly seen as an unacceptable hardship. In response, communities developed large-scale systems of levees and dams. The size of these structures and the complexity of their operation often required the development of civic and private organizations to carry efforts to control floods.

Yet working against nature had only limited success. As far back as 2025 BC, the Chinese recognized complete control of the Yellow and other rivers through dikes and levees alone was not possible. Emperor Yu the Great, a legendary figure in Chinese history and legend, was quite sophisticated in his approach, building both levees and dredging canals to divert the floodwaters to areas where they could be stored and conveyed with minimal harm. The Emperor recognized that making room for some flooding in a planned way provided greater protection throughout the entire system than trying to control the river. Indeed his 'taming' of the river was instrumental in his becoming emperor.[55]

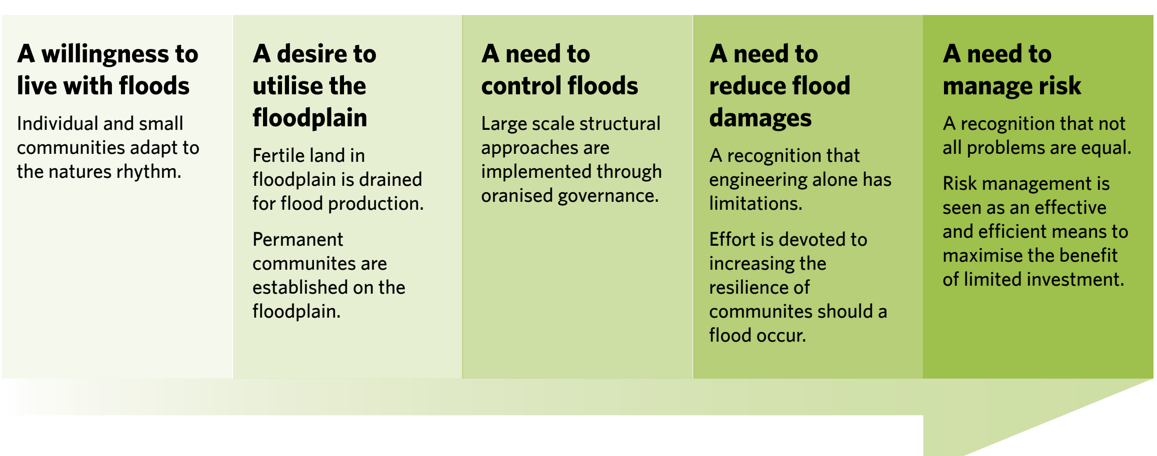
Yet, despite such examples, even today many other places around the world remain focused on flood control. Paradoxically, focus on controlling floods often increases risks and the potential for larger catastrophes. Structures like levees and dams may prevent small and medium size floods yet are overwhelmed by larger floods. When these flood control systems fail they often lead to the devastating loss of life and property, a problem which continues to this day.

This occurs for several reasons. First, flood control systems lead to a false sense of security and people aren't mentally or physically prepared to move out of the way of an oncoming flood. Second, the sense of security encourages development of permanent communities and settlements in flood prone areas. This perceived sense of security is known as the 'safe development paradox'[56].

In the United States, one particular event in the middle of the 20th made it readily apparent that structural approaches alone could not alone solve flood problems. The disastrous 1927 flood in the Lower Mississippi River Valley overwhelmed the existing flood control systems and resulted in great devastation and loss of life. Those responsible for flood management realized that any effort based on the premise that all floods could be prevented and that all areas could be protected was doomed to failure. In response, the US Army Corps of Engineers developed a comprehensive flood risk management approach for the lower Mississippi River valley that both identified and protected the inhabited areas and set aside other areas where excess floodwaters could be temporarily stored. This system, known as the Mississippi River and Tributaries system continues to this day – and has proven highly effective in reducing loss of life and property.[57] Yet in many other cases communities across the United States remain focused on trying to control floods.

The realization that absolute flood control is neither attainable nor affordable led to the development of a more comprehensive and holistic approach – comprehensive flood risk management. Flood risk management, as opposed to flood control, recognizes that flooding will occur and the focus must be on reducing risks. The goal of flood risk management is to minimize damages when these events happened.

Figure 2: The evolution of flood management practice through history.[58]



Key Elements of Comprehensive Flood Risk Management

Flood risk management requires understanding where the areas of greatest risk exist and focusing attention most on those areas. In addition, flood risk management focuses on using a variety of approaches and projects that work together to reduce overall risk. Such a portfolio of approaches includes land use planning to limit occupation of the most hazardous areas, planning for areas that will be allowed to flood, flood proofing of structures, the protection of individual structures and areas, the use of early warning systems, and risk transfer through the sale of insurance policies. The goal of this portfolio of strategies is to reduce overall risk – managing flood waters is one part – but not the only part of this approach.

Specifically, flood risk management has been defined to include a series of steps that are continually revisited and improved. These include:

- identifying the risk management goals to be achieved;
- understanding the hazards that exist;
- assessing the likely consequences of a hazard event;
- developing measures to deal with these risks – a risk strategy;
- implementing the risk strategy in a disciplined manner and,
- monitoring the results and adjusting the strategy over time

Figure 3: Flood Risk Management Cycle[59]

Marty Bahamonde/FEMA

These steps and the use of strategies that include a portfolio of approaches based on an understanding of risk and local conditions is how to build a path to a safer future. The 'Golden Rules" of flood risk management were captured in a recent UNESCO report.[60] The 'Golden Rules' include:

Promoting some flooding as desirable as floods and floodplains "provide fertile agricultural land and promote a variety of ecosystem services … and that making room for water maintains vital ecosystems and reduces the chance of flooding elsewhere."

Recognize that future conditions may be considerably different than those of the past and thus flexibility must be built into strategies through the selection of measures that can adjust to uncertainty and the integration of these strategies into other planning and development efforts.

Use a wide range of risk management measures to create a portfolio measures for mitigating flood damages and that best meet the established goals.

Where feasible, employ natural and nature-based natural approaches and natural and nature-based structural efforts.

Nature-based Approaches

Similarly, our efforts to address environmental degradation also need to evolve to a more comprehensive and integrated approach. To date, efforts to address the deterioration of the environment have focused on three general approaches: 1) pollution control; 2) protected areas; and 3) environmental assessment protocols. Recently, a fourth approach has been added: nature-based approaches.

Concern about the environment in general, and its relation to public health in particular, is not new. Control of wastes has been an issue from the earliest of times. As early as 2000 BC the people of the island of Crete used clay pipes to transport their water and wastes.[62] Later, in the 18th and 19th centuries, the growing understanding of the links between contagious diseases and human wastes led to a focus on pollution control – a focus that remains a priority for governments around the world. Pollution control remains a key element of environmental stewardship.

Effectiveness of Comprehensive Flood Risk Management

Planning, preparedness and coordinated responses - including floodplain management, early warning systems and increased public awareness of risk - have been shown to greatly improve the resilience of communities to natural hazards. Blending structural and non-structural flood management approaches is particularly cost-effective. It is likely that the targets in this domain could be met with a modest strategic investment in preparedness which will greatly reduce costs for relief and recovery from disasters. Well-designed national public employment programs using local resource-based work methods can have a large multiplier effect on vulnerable communities by combining the multiple objectives of employment generation, income support, asset creation and restoring the natural resource base.[61]

In Grenada, TNC is supporting the work of the community-based Woburn Bay Mangrove Restoration Team, a partner organization that is restoring a mangrove stand that had become a local garbage dump. © Marjo Aho for The Nature Conservancy

Similarly, as populations grew and technologies advanced, human development increasingly had impacts at a landscape scale. People began to understand the importance of protecting some wilderness and natural areas. This led to the establishment of protected areas as a key element of environmental protection. For example, in 10th century England, King Henry I instituted more formal protection of forest areas because of their value as royal hunting grounds. In the United States, the beginning of the industrial revolution during the 19th century helped spark the conservation and resource management movement. The writings of thought leaders like Henry David Thoreau and John Muir were instrumental in capturing both the underlying ethic and the need to protect wilderness areas – efforts that ultimately led to the development of the National Park System and other protected public areas. Protected areas are another key element of environmental stewardship.

The growing understanding of the cumulative and often irreversible impacts of development activities, countries began to develop and use environmental assessment protocols to study and assessment of impacts of projects before they were approved. In the United States, the National Environmental Policy Act was passed into law in 1970 – part of a wave of environmental laws in response to the growing public concern about environmental impacts. Environmental assessments protocols are the third leg of the environmental protection.

Each of these three elements – pollution control, protected areas, and environmental assessment protocols, is critical to reducing degradation of the environment. But they have not been enough. There is a growing recognition of the need to consistently incorporate nature-based approaches directly into our development-related activities and our actions to meet our basic human needs. Protecting and restoring nature needs to become an explicit project outcome of these public and private investments. Consistently incorporating nature and nature-based approaches into development and other projects is a critical fourth element of environmental sustainability which needs to be more consistently used

The concept of sustainable development is not a new idea. The concept was first articulated in 1987 in the United Nations sponsored report – Our Common Future[63] -- defined the need to directly link development and environmental protection. Both development and environmental protection were recognized as critical to alleviating poverty around the world. The report provided a clear definition of sustainable development:

> *Environment and development are not separate challenges; they are inexorably linked. Development cannot subsist upon a deteriorating environmental resource base; the environment cannot be protected when growth leaves out of account the costs of environmental destruction.*[64]

The report presented an optimistic view, stating:

> *We see instead the possibility for a new era of economic growth, one that must be based on policies that sustain and expand the environmental resource base. And we believe such growth to be absolutely essential to relieve the great poverty that is deepening in much of the developing world.*[65]

Now, 30 years later, there must be a renewed commitment to the goal stated in Our Common Future, that economic growth must be based on policies that sustain and expand the environmental resource base. Nature-based approaches are uniquely able to bridge the goals of economic development, environmental sustainability, adaptation to climate change, and disaster risk reduction (see Appendix 1). By explicitly recognizing the many key functions that natural systems and features provide and deliberately incorporating them into a wide variety of programs and projects we can collectively achieve the broad vision of sustainable development and help achieve the specific Sustainable Development Goals and climate change commitments.

Development Benefits of Nature-based Approaches

The natural areas and functioning ecosystems protected and restored through consistent integration in flood risk management provide critical services to support sustainable and resilient economic and social development. Table 2 provides an overview of the broad range of benefits. Specifically, these approaches would help meet specific SDGs, including:

- **Goal 2. End hunger, achieve food security and improved nutrition and promote sustainable agriculture** - Coastal marshes, wetlands and floodplains provide critical nursery, rearing and foraging areas for subsistence, commercial and recreational fisheries and water fowl.
- **Goal 3. Ensure healthy lives and promote well-being for all at all ages** Forests, trees and other green areas, both urban and rural, improve air quality, provide areas for exercise and recreation.
- **Goal 6. Ensure availability and sustainable management of water and sanitation for all** – forests and natural riparian areas filter water and recharge groundwater, protect the quality and quantity of drinking water sources.
- **Goal 11. Make cities and human settlements inclusive, safe, resilient and sustainable**– development of green spaces, parks in cities provide areas for recreation, exercise, reflection. Urban green spaces can improve air quality and serve as planned floodwater detention areas.
- **Goal 13. Take urgent action to combat climate change and its impacts** - forests, wetlands, marshes, and seagrasses are all important natural processes for sequestering carbon and reducing risks from floods and storms.
- **Goal 15. Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss** – forests in watersheds provide sustainable forest products and crops.

RIVER FEATURES	ECONOMIC & NATIONAL DEVELOPMENT
» Conserving/restoring forests	» Water purification, tourism, recreation, wildlife habitat
» Conserving/restoring floodplains/riparian lands/ forests	» Food Provisioning (fish, birds), water purification, recreation, wildlife Habitat
» Reconnecting river to floodplains	» Food Provisioning, (fish, birds) water purification, recreation, wildlife Habitat
» Conserving/restoring wetlands	» Food Provisioning (fish, birds), water purification, wildlife habitat,
» Constructing wetlands	» Water purification, wildlife habitat
» Establishing flood bypasses	» Flood defense
» Identifying and protecting backwater areas	» Flood defense, water purification, wildlife habitat,
» Fish/flood friendly culverts/bridges	» Flood defense, wildlife habitat
» Establishing flood water detention areas	» Flood defense, wildlife habitat
» Establishing filter strips, grassed waterways on tilled farm fields	» Water purification
COASTAL FEATURES	**ECONOMIC & NATIONAL DEVELOPMENT**
» Conserving/restoring beach & coastal dunes	» Tourism and recreation, water purification
» Conserving/restoring coral reefs	» Nature, tourism, food provisioning (fish)
» Conserving/restoring mangroves	» Provisioning of food and firewood, tourism, carbon fixation
» Conserving/restoring riverine wetlands	» Nursery, carbon fixation, water purification
» Conserving/restoring salt marshes	» Food provisioning (fish, birds), nursery for seafood species, carbon fixation
» Conserving/restoring shellfish reefs	» Food provisioning (fish and shellfish), water purification
» Conserving/restoring seagrass	» Food provisioning (fish and shellfish), nursery for fish, clam habitat
» Conserving/restoring intertidal flats	» Shellfish production
» Building living shorelines	» Erosion control, wildlife habitat
COMMUNITY/URBAN FEATURES	**ECONOMIC & NATIONAL DEVELOPMENT**
» Daylighting Rivers and Streams	» Aesthetics, recreation, quality of life, wildlife habitat
» Building parks, recreational spaces	» Recreation, aesthetics, quality of life
» Bio swales, stormwater recharge areas	» Water purification, aesthetics, recreation
» Greenways, bikeways	» Recreation, aesthetics, quality of life
» Green roofs	» Water purification
» Rain gardens, victory gardens (neighborhood gardening plots)	» Recreation, aesthetics, quality of life
» Green Streets/Green Parking lots	» Water purification
» Rainwater harvesting	» Water supply
» Permeable pavement	» Water purification

Climate Adaptation Benefits of Nature-based Approaches

Natural areas and functioning ecosystems also help meet the commitments under the Paris climate agreement. These benefits contribute both to mitigation of emissions and to the need to adapt to the impacts and effects of climate change, particularly related to impacts from extreme weather events. Specific examples include the ability of natural systems to:

Sequester Carbon – floodplain forests, mangroves, wetlands, marshes, and sea grasses are all important natural processes for sequestering carbon

Keep people and structures out of harm's way – protected natural areas within flood risk zones keep people and structures out of high risk areas, reducing damages and losses.

Flood storage – floodplain and backwater areas store water during flood events.

Improve flood conveyance – side channels and bypass reaches can move flood waters downstream.

Slow conveyance – forests, intact riparian areas, wetlands and other natural areas can slow flood waters and storm surges avoiding peak discharges downstream

Reduce peak flood stage- storing water, slowing conveyance upstream and improving conveyance in key areas are all important tools to reduce peak flood stages.

Reduce erosion and sedimentation – forests, intact riparian areas, and other natural areas help to reduce erosion by either avoiding bare soils or serving to filter and trap sediments moving with water over land.

Reduce wave height – reefs, mangroves and marshes reduce wave heights

Nature - based approaches are particularly well suited to the effects of climate change as ecosystems are adaptive in multiple ways.[66] For example, many coastal ecosystems are able to retain and accrete sediments as water levels rise and allows them to grow in pace with sea level.[67,68] This suggests that even though sea level is rising, the intertidal areas may be able to keep pace with water depth along. These shallow nearshore areas reduce future wave heights. Additionally, ecosystems can recover from low and intermediate impact events.[69,70]

The Path to Sustainability

Two Strategies, One Path: Integrating Nature-based Approaches into Comprehensive Flood Risk Management

There is increasing recognition of benefits to both people and nature by including nature-based approaches within comprehensive flood risk management. Given the urgent needs related to sustainable development, the changing climate and reversing environmental degradation, nature-based approaches should consistently become a piece of comprehensive approaches to flood risk management. Desired environmental outcomes should be proactively and explicitly integrated into the overall portfolio of approaches used in comprehensive flood risk management and into the design of individual projects and programs.

The path to a safe and sustainable future can be more readily achieved when nature-based approaches are integrated into each of the phases of the flood risk management cycle (Figure 2.1). Ensuring the environmental goals are included at the outset as a key desired outcome of risk management will help ensure strategies are developed which both sustain environmental resources and reduce risks.

Setback levees along the lower Mississippi River. © David Y. Lee

The goals setting under FRM should include both ecosystem goals as well as flood risk management goals. These goals must also be set within the context of meeting development goals and with climate change in mind.

The hazard identification should include an assessment of ecosystem status, as deteriorating ecosystems can increase the risk from floods. Loose of wetlands, marshes, reefs, and floodplains can all increase flood risks to those nearby.

The risk analyses should include ecosystem functioning to assess how ecosystems currently mitigate risk. Such analyses will determine the desired requirements for the ecosystem, such as size, and combined with the current status this can potentially result in a management strategy for ecosystems as an integrated part of the risk strategy.

Management strategies should include ecosystem restoration and conservation as the protection or restoration of natural areas and natural features can integral to the risk reduction strategy. They should also include approaches that restore or replace natural functions, such as the infiltration of water and recharge of groundwater. During implementation this will lead to including management measures to maintain these systems.

The implementation of risk management strategies must include the active protection and restoration of natural features. These areas often suffer from encroachment from development and agriculture, degradation from pollution, or degradation from pollution or other insults.

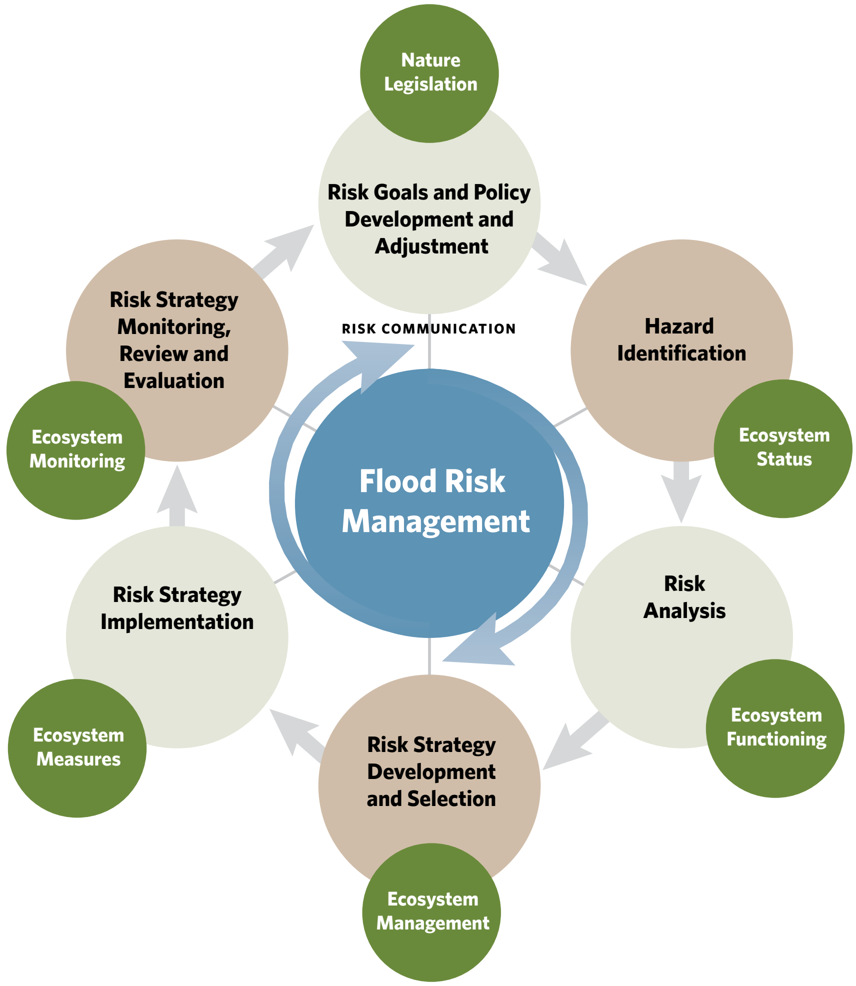
The monitoring of effectiveness of measures should also include monitoring of ecosystem status over time. Monitoring results may lead to intervention and the adjustment of measures as changes occur.

The benefits of nature-based approaches to flood and storm defenses are becoming more widely recognized around the world. For example, the World Bank has released principles and implementing guidance for use of nature-based approaches.[73] They identify five principles for including consideration of nature-based approaches and eight steps of implementation guidance. The five principles are[74]:

1. **System-scale perspective:** Addressing nature-based solutions for climate change adaptation and disaster risk reduction should start with a system-wide analysis of the local socio-economic, environmental, and institutional conditions.
2. **Risk and benefit assessment of full range of solutions:** A thorough assessment of risks and benefits of the full range of possible measures should be conducted, covering risk reduction benefits as well as social and environmental effects.
3. **Standardized performance evaluation:** Nature-based solutions for flood risk management need to be tested, designed, and evaluated using quantitative criteria.
4. **Integration with ecosystem conservation and restoration:** Nature-based solutions for flood risk management should make use of existing ecosystems, native species, and comply with basic principles of ecological restoration and conservation.
5. **Adaptive management:** Nature-based solutions for flood risk management need adaptive management based on long-term monitoring. This ensures their sustainable performance.

Integrating nature-based approaches into the flood-risk management cycle will help ensure a full portfolio of approaches and projects, including traditional, nature-based, and combinations of both, are considered and deployed. Including nature-based approaches in the flood risk management cycle will both reduce risks and improve environmental conditions thereby supporting economic and social development and help communities adapt to climate change.

Figure 3: Ecosystems in the flood risk management cycle.[71,72]



Flood Defense Benefits of Nature-based Approaches

One of the key benefits of natural features and nature-based approaches are the flood risk benefits they provide for the hazards of large flood and storm events and more frequent nuisance flooding and erosion events. These features include natural systems such as reefs, floodplains, wetlands and marshes. In addition, maintaining key natural functions such as the natural movement of sediment and sand either along shores or in rivers, are critical to the sustainability of these natural features and the benefits they provide.

Areas that are naturally frequently flooded and can serve as areas for planned flooding are often low-lying and wetland, floodplain and coastal areas that have extremely high biodiversity and natural resource values.

The protection and restoration of wetlands and marshes help slow store water and increase infiltration to groundwater.

The protection and restoration of forests, particularly upstream and riparian forests, can slow water, increase evapotranspiration and reduce risks of landslides on steep slopes.

In coastal areas, reefs, marshes, dunes and sea grasses serve as natural barriers to waves and storm surges. Natural shoreline and coastal vegetation reduces erosion and scour. These nature features are also critical components of coastal ecosystems.

Table 2 provides a list of various nature-based approaches to flood and storm risk reduction and the flood defense benefits they provide. The function of these approaches for coastal, river and urban flooding is briefly discussed.

Table 2: Flood Defense Benefits of Nature-based Approaches

RIVER FEATURES	FLOOD DEFENSE PROPERTIES
» Conserving/restoring forests	» Slow water speed, increase evapotranspiration, reduce erosion
» Conserving/restoring riparian lands/forests	» Store flood waters, slow water speed, infiltrate water to groundwater, reduce erosion
» Reconnecting river to floodplains	» Increase storage, increase conveyance
» Conserving/restoring wetlands	» Increase storage, increase infiltration to groundwater, reduce erosion
» Constructing wetlands	» Increase storage, increase infiltration to groundwater, reduce erosion
» Establishing flood bypasses	» Increase conveyance
» Identifying and protecting backwater areas	» Store flood waters
» Fish/flood friendly culverts/bridges	» Increase conveyance
» Establishing flood water detention areas	» Store flood waters, increase conveyance
» Establishing filter strips, grassed waterways on tilled farm fields	» Slow water, reduce erosion
COASTAL FEATURES	**FLOOD DEFENSE PROPERTIES**
» Conserving/restoring beach & coastal dunes	» Flood defense, reduce erosion and enhance entrapment of sand
» Conserving/restoring coral reefs	» Reduce wave energy, sediment provisioning
» Conserving/restoring mangroves	» Reduce wave impact and current velocities, reduce erosion
» Conserving/restoring coastal wetlands	» Flood defense, water retention, reduce erosion, enhance accretion
» Conserving/restoring salt marshes	» Wave dampening, reduce erosion, enhance accretion
» Conserving/restoring shellfish reefs	» Reduce wave energy, reduce erosion, enhance accretion
» Conserving/restoring seagrass	» Mediation of currents and waves, reduce erosion
» Conserving/restoring intertidal flats	» Limit wave height, reduce fetch
» Building living shorelines	» Reduce erosion
COMMUNITY/URBAN FEATURES	**FLOOD DEFENSE PROPERTIES**
» Daylighting Rivers and Streams	» Increase conveyance
» Building parks, recreational spaces	» Flood water storage, increase conveyance
» Bio swales, stormwater recharge areas	» Recharge water to groundwater, flood water storage
» Greenways, bikeways	» Flood water storage
» Green roofs	» Slow water, increase evapotranspiration
» Rain gardens, victory gardens (neighborhood gardening plots)	» Recharge water to groundwater, slow flood water, flood water storage
» Green Streets/Green Parking lots	» Recharge water to groundwater
» Rainwater harvesting	» Slow water
» Permeable pavement	» Recharge water to groundwater

Nature-based Approaches to Coastal Flooding

Coastal ecosystems can play a role in the mitigation of waves, storm surges and tsunamis[75,76]. Early studies stressed the importance of ecosystems for wave reduction.[77,78] Several overviews deal with the role that marshes play on wave attenuation and coastal erosion reduction[79] and since the Asian tsunami, the role of mangroves in mitigating wind and swell waves, storm surges and tsunamis has been investigated.[80,81,82,83] In other areas, with much wider mangrove belt (up to over a kilometre in width) the presence of mangroves was shown to reduce damage and fatalities significantly.[84] Another good example of the mitigating role of vegetation is constituted by the Japanese tsunami where flood protection forest significantly decreased inland penetration of the tsunami after levee failure.[85] Similarly, numerous measurements on mangroves and wave dampening exist. Mangroves also help to stabilize shorelines and trap sediments.[86]

For quantification of the role that ecosystems play in wave attenuation, there are numerous field measurements on attenuation over for example salt marsh surfaces with low water levels and low wave heights. Experiments have also been completed to show their effectiveness during highwater storm surge events.[87] Coastal features such as reefs, beaches, marshes and mangroves all have varying ability to reduce wave heights. Similar research efforts have been dedicated to the role that corals play with respect to both wave dampening and wave breaking on the crest.[88] Reefs in particular have been shown to reduce wave heights by 70%.[89]

Despite the scientific evidence of the functional role that coastal vegetation can play for mitigating flood risk there are only few examples of implementation of coastal vegetation in coastal protection schemes. Several models for wave attenuation that include vegetation effects exist[90,91] and can give a reasonable prediction of the effects of waves moving through vegetation. Through the use of these models attenuation of waves with different incoming heights can be well predicted for submerged vegetation versus non-submerged vegetation and for the length that the wave travels over the vegetation.

Most good case studies are based on properties of sediment as the main buffer, such as with beach and dune systems. In this case vegetation plays a role for sediment trapping and stabilization but not for mitigation of hydraulic forces. Although mangrove replanting efforts are massive nowadays most of them are local efforts from grass root organizations and are not implemented from a broader coastal management perspective.

Nature-based Approaches to River Flooding

Wetlands and forests are important to slowing water as it travels across land, reducing downstream flooding. Floodplains in natural conditions are important areas to store water and convey it downstream. They are also critical to maintaining natural sediment and nutrient regimes.

Downstream measures focus on increasing discharge capacity of rivers by creating extra space in the floodplain and removing bottlenecks through river widening and bypasses. In addition, vegetation can even be considered to reduce discharge capacity through increasing roughness and resistance in the floodplain.[92] Floodplain wetlands increase floodplain roughness and slow the discharge, which can mitigate peak flows. However, out of bank flooding will occur, and especially for extreme events, having areas which are planned to receive these flood waters are key to reducing overall damages.

Upstream measures for flood management focus on maintaining natural forest and grass cover in the watershed. Foliage act as an umbrella that reduces raindrop impacts on the soils, thereby decreasing the risk of erosion and landslides. Roots strengthen the soil and improves soil texture, which increases the retention (sponge) capacity. Organic matter from roots and leaves improves soil structure and increases both infiltration rates and water-holding capacity that is, the ability of the soil to retain water against gravity.[93] Maintaining forest cover, reforestation and use of perennial crops in upper watershed areas reduce flood peaks by incepting and slowing water. These approaches also reduce erosion and therefore help maintain the flow capacity of rivers. The impact of catchment restoration on flood peak reduction will be larger in smaller catchments.

TNC: Mark Godfrey

Finally, in rivers and lakes with large fetches wetlands and vegetation can play a role in attenuating waves.[94] This application has many features in common with brackish or salt water wetlands and their capacity to attenuate waves. A study in the Netherlands[95] compared three natural and nature-based approaches and natural and nature-based flood defenses with traditional levees for both construction and maintenance. Here, the construction of the nature-based approaches also was less expensive. This difference is mostly caused by the fact that vegetation in front of the levee mitigates hydraulic forces, especially waves, which allows for cheaper levee designs. The costs that are saved on construction far exceed the marginally extra costs for monitoring and maintenance.

Perhaps most importantly, protecting natural areas along coasts and rivers help keep people and structures out of harm's way – ensuring development is set back from the areas of highest hazard.

Comprehensive Flood Risk Management Approach: Mississippi River and Tributary Program

The Mississippi Rivers and Tributary Project, developed after the catastrophic flood of 1927, includes the use of a comprehensive approach, including both extensive traditional structural approaches and some nature-based approaches. One of the key elements is the inclusion of a 'room for the river' approach that includes floodways, emergency flood bypass areas and backwater areas where planned flooding can happen. The plan included elements of equity as well, compensating landowners through payment for easements for the right to flood their land during floods.

TNC: Mark Godfrey

Natural and nature-based Approaches to Poor Drainage/ Urban Flooding

Nature-based green spaces, urban wetlands, bio-swales and permeable paving for roads and parking lots lead to an increase of infiltration capacity, thereby reducing the flood hazard. Green areas such as parks and water bodies also act as retention areas. To reduce peak flows from surface runoff, process storm water infiltration facilities and other best management practices, also called sustainable urban drainage systems (SUDS) have, since the late 90's been increasingly implemented.[96,97] Green roofs, which catch and store rainwater, are also rapidly growing in popularity.

Vegetation can have a mitigating effect on the impact of heavy rains in urban areas. Conservation of urban wetlands and implementation of wetlands as retention and infiltration areas in the storm water run-off infrastructure of cities will serve multiple goals, such as retention and infiltration areas, improving water quality and providing natural areas in urban environments. China has embarked on an ambitious program to create 'sponge cities' to both reduce flood damages and improve water availability.[98] Reviving and conserving these wetland areas also offers large potential in many rapidly developing megacities in India, Indonesia and Africa.

Recommendations

The path to a safe and sustainable future in the face of disasters and environmental degradation must be built on a strong foundation – and comprehensive flood risk management and environmental sustainability are critical cornerstones of this foundation.

The SDGs clearly recognize the importance of both risk reduction and environmental sustainability as key elements to achieving our shared goals. The Paris Climate agreement also recognizes the need for adaptation to climate change and plan for the adverse impacts, including disasters, which it will bring. Together these goals and commitments can be the basis for efforts that reach a tipping point in the amount of investment in flood risk management and in advancing environmental sustainability through the use of nature-based approaches to flood and disaster risk management and to meet the social, economic and health needs of people around the world.

Recommendations

As the world embarks on implementing the SDGs and the commitments underpinning the Paris Agreement, comprehensive flood risk management and broad use of nature-based approaches are important strategies which are key elements of global and national efforts to achieve sustainable development. To more consistently advance these strategies, there is the need to identify and commit to explicit goals to advance their use. Specifically, this should include:

Increase investment in pre-disaster mitigation planning and projects

- Greatly increase the investment in all steps of the flood risk management cycle, including disaster preparedness, disaster mitigation, and post-disaster recovery plans. A global target should be set for increasing the investment in holistic disaster risk management from the current condition of less than 1/2 of 1 percent of development aid. A significant portion of this increased investment should be focused on investments in natural and natural and nature-based approaches that also are designed to provide benefits to development, disaster risk reduction, and environmental sustainability goals. Consistently include comprehensive flood risk management, including the consistent use nature-based approaches, in key global, bi-lateral, regional and national funding sources, including the Green Climate Fund and the Global Environment Facility (GEF) funds.
- Increase the focus on reducing future flood risks by ensuring disaster recovery efforts are focused on building back safer. Recovery plans must outline the needed improvements to existing infrastructure, systems, and community conditions to ensure the when disaster recovery funding becomes available post disaster they can be put to use not putting things back the way there, but rather be used to 'build back better' – in a way that further advances the risk management approaches. Post-disaster provides a unique opportunity to correct 'mistakes' of the past – but will only occur if plans for such changes are in place before the disaster strikes and recovery aid begins to flow.

Increase investment in nature-based approaches through public and private investments

- Establish protocols that nature based approaches should always be considered in disaster and flood risk management efforts and implemented where achieving multiple benefits are cost effective. In addition, a global target should be established for the level of infrastructure investments which include nature-based approaches. Over the next 10 years global infrastructure investment is expected to grow from $4 trillion to $9 trillion for all causes.[99] By consistently including nature in the investments to improve disaster risk management and build new infrastructure – public and private, large and small, these investments will also more effectively achieve the sustainable development goals for communities and nations across the globe.
- The implementation of the Paris climate goals, including the adaptation goals, should focus on the inclusion of nature-based approaches as one of the primary tools in the portfolio of approaches taken to meet adaptation commitments.

Support Improvement of National Policies

- Several developed and developing nations have successfully moved the focus and increased the level of investments to disaster preparedness and pre-disaster mitigation projects. Global organizations, including multi-lateral organizations, should increase efforts to collect and disseminate these examples and document the benefits they have realized.

Invest in Science and information

- There is the need for continued research and evaluation of the most effective flood and disaster risk management approaches, post-disaster recovery actions, and nature-based approaches.
- There should be continued research on the flood and disaster risk benefits of various nature-based approaches to document their ability to contribute to national development goals.
- Build on the existing work to integrate nature-based approaches into standard flood risk management frameworks.
- Continue to support the implementation of projects that demonstrate the effectiveness of nature-based approaches and natural and nature-based measures.

Broaden Education and Outreach

- Continue to provide information on comprehensive flood risk management and the role nature can play in these approaches to broaden understanding of benefits these approaches. This should include technical information on when and how such approaches are most appropriate:

Conclusion

With the adoptions of the SDGs and commitments to address climate change in the Paris Agreement this is a time when nations and communities can fully embrace the use of nature-based approaches to meeting our development goals and as integral to comprehensive flood risk management. Increased awareness of climate change and the far reaching changes is galvanizing global and national institutions to more consistently consider climate impacts in their decisions related to development, disasters, and environmental sustainability.

Comprehensive flood risk management recognizes the need to focus on pre-disaster preparedness and mitigation, to anticipate and plan for flooding, to include nature-based approaches, and to shift the paradigm from building against nature to 'building with nature'. Nature-based approaches are uniquely able to provide multiple benefits to address many needs.

Comprehensive flood risk management and nature-based approaches are not sufficient, by themselves, to meet the sustainable development goals and the Paris Climate Agreement commitments. But absent these approaches, these goals and commitments are unlikely to be reached.

Appendices

Appendix 1: Benefits of nature based approaches to social, flood and environmental goals.

Contribution of Nature-based approaches to Flood Defense, Development and Environmental Sustainability Outcomes

		FLOOD & STORM DEFENSE BENEFITS							DEVELOPMENT BENEFITS								ENVIRONMENTAL BENEFITS				
NATURE-BASED APPROACH	ECOSYSTEM SERVICE	KEEP OUT OF HARM'S WAY	FLOOD STORAGE	IMPROVE FLOOD CONVEYANCE	SLOW CONVEYANCE	REDUCE FLOOD STAGE	REDUCE EROSION	REDUCE WAVE HEIGHT	PROTECT DRINKING WATER	PROVIDE FOOD SOURCES	IMPROVE AGRICULTURE	IMPROVE FISHERIES	IMPROVE URBAN QUALITY OF LIFE	IMPROVE AIR QUALITY	IMPROVE FORESTRY	REDUCE WATER POLLUTION	CONSERVE BIODIVERSITY	IMPROVE WATER QUALITY	REDUCE SEDIMENTATION	WATER TEMPERATURE CONTROL	CARBON SEQUESTRATION
FLOOD - RIVER FEATURES																					
Conserving/ restoring forests					+		+		+	+				+	+	+	+	+	+	+	+
Conserving/ restoring riparian lands/forests		+			+		+		+	+				+	+	+	+	+	+	+	+
Reconnecting river to floodplains			+	+		+	+			+		+				+	+	+	+	+/-	+
Conserving/ restoring wetlands		+	+		+		+		+	+		+				+	+	+	+		+
Constructing wetlands			+		+		+		+			+				+	+	+	+		+
Establishing flood bypasses				+		+											+/-				
Protecting backwater areas		+	+		+	+	+			+		+				+	+	+	+	+/-	+
Fish/flood friendly culverts/bridges				+		+				+		+					+		+	+	
Establishing flood water detention areas		+	+	+/-	+	+															+/-
Establishing filter strips on farm fields					+	+	+		+		+	+				+	+	+	+		

COASTAL FEATURES

Conserving/ restoring coastal marshes	+					+	+		+		+				+	+	+	+		+
Conserving/ restoring beaches and dunes	+					+	+									+				
Conserving/ restoring coral & shellfish reefs						+/-	+		+		+				+	+	+			+
Conserving/ restoring mangroves						+	+		+		+		+		+	+	+	+	+	+
Building living shorelines						+	+				+				+	+	+	+		+
Conserving/ restoring intertidal flats						+	+/-		+		+				+	+	+			+

COMMUNITY/URBAN FEATURES

Daylighting Rivers and Streams			+								+/-	+				+	+			
Building parks, recreational spaces	+		+									+								
Bio-swales, stormwater recharge areas				+	+	+		+			+	+			+	+	+	+	+	+
Greenways, bike trails	+											+			+					
Green roof initiatives				+		+						+	+		+		+		+	
Rain gardens, victory gardens				+		+			+			+			+		+	+	+	
Green Streets/ Green Parking lots				+		+						+			+		+	+		
Rainwater harvesting				+		+						+			+					
Permeable pavement				+		+						+			+		+	+	+	

Key: + = strong positive effect, + = positive effect +/- = generally positive effect but could be negative depending on circumstances

Appendix 2: Timeline of Key Actions related to Climate and Disaster Risk Reduction at the Global Level

(Modified from: Milestones in the History of Disaster Risk Reduction: http://www.unisdr.org/who-we-are/history)

Significant Milestones of the Last Forty Years Related to Disasters, Development, Climate, and Environmental Sustainability

1972 UN Conference on the Human Environment (Stockholm) 1979 — The first World Climate Conference (WCC) takes place.

1988 — The Intergovernmental Panel on Climate Change (IPCC) is established.

1990 — IPCC's first assessment report released. IPCC and second World Climate Conference call for a global treaty on climate change. United Nations General Assembly negotiations on a framework convention begin.

1992 United Nations Conference on Sustainable Development (Rio de Janeiro) reaffirmed the 1972 Stockholm document and produced a detailed agenda of action, known as Agenda 21.

Agenda 21 included a detailed set of actions and recommendations related to disaster risk management, focusing on the need for nations to embrace a risk management framework.

1987 – U.N. Resolution 42-169 declaring 1990s as the International Decade of Natural Disaster Reduction to foster efforts to cooperatively to improve the capacity of nations to reduce the damages and losses from natural disasters, through support work on the science, engineering and other aspects of disaster risk reduction.

1994 – Yokohama Strategy and Plan for a Safer World: Guidelines for Natural Disaster Prevention, Preparedness and Mitigation (Yokohama, Japan), was issued at the midway point during the decade of disaster prevention, and further articulated a risk management approach, focusing on disaster prevention, mitigation, preparedness and relief. 1995 — The first Conference of the Parties (COP 1) takes place in Berlin.

1997 — Kyoto Protocol formally adopted in Japan in December at COP3. The protocol was a commitment by nations to bind themselves to emission reduction targets for greenhouse gases. Recognizing that industrialized nations had been more responsible for emission of greenhouse gases to date, the protocol embodied the principle of "common but differentiated responsibilities."

2000 - Millennium Declaration and Millennium Goals (New York) established a broadly endorsed set of development goals with clear and time bound desired outcomes. The UN Millennium Development Goals are broadly focused on eradication of poverty and hunger, education, gender equality, reduction in child mortality, maternal health combating disease, ensuring environmental sustainability and building a global partnership for development.

2005 – Hyogo Framework for Action 2005-2015: Building Resiliency for Nations and Communities (Hyogo) is the foundational framework for DRR work at the global level. The Framework was the 'international acknowledgement that efforts to reduce risks much be systematically be integrated into policies, plans and programmes for sustainable development and poverty reduction, and supported through bilateral, regional and international cooperation, including partnerships' (Preamble A.4).

2007 — IPCC's Fourth Assessment Report released. Climate science entered into popular consciousness.

2012 -- Report of the United Nations Conference on Sustainable Development (Rio +20) revisited the sustainability goals from the 1992 meeting and Rio. The report called for the development of specific sustainability development goals, along the lines of the Millennium Development goals.

2014 –Sustainable Development Goals. There are a number of efforts underway to develop the post-2015 development goals with various UN related organizations drafting papers to inform the discussion. Many of these efforts more directly link development, sustainability, risk reduction and water management.

2012 - The Doha Amendment to the Kyoto Protocol is adopted by the CMP at COP8. This amendment added a second commitment period for emission reductions of 2013-2020.

A Post-2015 Global Goal for Water: Synthesis of key findings and recommendations from UN-Water (January, 2014) The UN Special Thematic Session on Water and Disasters in March 2013 highlighted the particular linkages between water and disasters.

Water and Disaster Risk: A contribution by the United Nations to the consultation leading to the Third U.N. Conference on Disaster Risk Reduction A holistic approach that integrates water into socio-economic development planning is being adopted and should be further supported.

Partnership for Environment and Disaster Risk Reduction (PEDRR) Formally established in 2008, the Partnership for Environment and Disaster Risk Reduction (PEDRR) is a global alliance of UN agencies, NGOs and specialist institutes. As a global thematic platform of the International Strategy for Disaster Reduction (ISDR), PEDRR seeks to promote and scale-up implementation of ecosystem-based disaster risk reduction and ensure it is mainstreamed in development planning at global, national and local levels, in line with the Hyogo Framework for Action.

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