

# Concern Disaster Risk Reduction - Coastal Areas



Centre for  
Humanitarian Action

**CONCERN**  
worldwide



## Acknowledgements

This publication draws on ten years of experience from Concern Worldwide's disaster risk reduction programming experience in coastal areas. The publication is part of a series documenting Concern's approach to disaster risk reduction. The series consists of five context papers focusing on DRR approaches in mountainous, dryland, coastal, urban, and riverine contexts. A sixth paper synthesises conclusions from these context papers and identifies how Concern uses DRR to contribute to building community resilience.

The success of our programmes is largely due to the invaluable insights and commitment of thousands of programme participants, community leaders, local government officials and other community members. It is our great honour and privilege to partner with local organisations, communities and ministries. We would also like to acknowledge Concern's dedicated field staff, who have devoted countless hours ensuring that our programmes are constantly striving to reach the most vulnerable with the highest quality of programming possible. Special thanks are due to devoted teams leaders, programme managers, advisers and country directors that have championed Concern's work on disaster risk reduction.

We gratefully acknowledge the support of our donors, both public and institutional, which have supported Concern's disaster risk reduction programmes. Concern also wishes to acknowledge the valuable support of other agencies implementing and researching disaster risk reduction and the various consultants that participated in evaluations.

Finally, this publication would not have been possible without the technical expertise and editorial support of a range of individuals. Key contributors to this publication are listed below.

### Lead Author

Aaron Clark-Ginsberg  
Disaster Risk Reduction Documentation Officer  
*Concern Worldwide*

### Editing

Dom Hunt  
Disaster Risk Reduction Adviser  
*Concern Worldwide*

### Design and Layout

Kai Matturi  
Knowledge and Learning Adviser  
*Concern Worldwide*

### Cover Image

A coastal settlement in the Sunderban area, Bangladesh, 2014. Photo by Aaron Clark-Ginsberg, 2014.



## **Contents**

<b>Executive Summary</b>	<b>4</b>
<b>Introduction</b>	<b>7</b>
<b>Coastal areas and disaster risk reduction</b>	<b>9</b>
<b>Overview of the coastal case studies and Concern</b>	<b>13</b>
<b>Concern's approach to disaster risk reduction in coastal areas</b>	<b>19</b>
<b>Conclusion</b>	<b>53</b>

## Acronyms and Abbreviations

<b>CAG</b>	Contextual Analysis Guidelines
<b>CBO</b>	Community-Based Organisation
<b>CFW</b>	Cash for Work
<b>DFID</b>	Department for International Development
<b>DMC</b>	Disaster Management Committee
<b>DRR</b>	Disaster Risk Reduction
<b>DRM</b>	Disaster Risk Management
<b>EWS</b>	Early Warning Systems
<b>HCUEP</b>	How Concern Understands Extreme Poverty
<b>HDI</b>	Human Development Index
<b>HFA</b>	Hyogo Framework for Action
<b>ICZM</b>	Integrated Coastal Zone Management
<b>NGO</b>	Non-Governmental Organisation
<b>NRM</b>	Natural Resource Management
<b>PIPs</b>	Policies, Institutions, and Processes
<b>PEER</b>	Preparedness for Effective Emergency Response
<b>RAG</b>	Risk Analysis Guidelines
<b>UNEP</b>	United Nations Environmental Programme
<b>UNISDR</b>	United Nations International Strategy for Disaster Reduction
<b>WASH</b>	Water, Sanitation, and Hygiene



## Executive Summary

This report describes Concern Worldwide's approach to disaster risk reduction (DRR) in coastal areas. This context was chosen to showcase Concern's approaches to addressing hazards typically found in these areas – **cyclones/hurricanes** and their associated **storm surges, salinisation, coastal erosion** and, in some cases, **tsunami**.

Concern Worldwide is a non-governmental, international, humanitarian organisation dedicated to reducing suffering and working towards the ultimate elimination of extreme poverty in the world's poorest and most vulnerable countries.

Concern works closely with and for the poorest and most vulnerable people in these countries, directly enabling them to improve their lives. Concern understands that disasters are a central factor causing and maintaining poverty. For more than a decade and across more than 25 countries, Concern has been using DRR to address risks associated with disasters and contribute to building community resilience.

To innovate, improve, and capture good practices and lessons to be learned, Concern has documented its experiences in DRR and has produced a series of papers based on its DRR programming in ten countries. Practitioners, policy makers, and academics can use these papers to understand how Concern reduces risk in different geographic contexts and with different hazards.


The series consists of five context papers focusing on DRR in mountainous, dryland, coastal, urban, and riverine contexts. A sixth paper synthesises conclusions from these context papers and identifies how Concern uses DRR programming to contribute to building community resilience.

Managing disaster risk in coastal areas is a vital component of sustainable coastal development. 123 countries have coastlines, coastal areas comprise 20% of the Earth's surface, and over 50% of the world's population lives within 100 kilometres of the coast. Many of these people are exposed to coastal hazards. Climate change and rising sea levels are expected to exacerbate this exposure.

This paper documents and compares Concern's work across three different coastal areas: the island of La Gonâve, off the coast of Port au Prince in **Haiti**; the Chinde district of Zambezia province, **Mozambique**; and the Sunderban region of **Bangladesh**. Each of these areas is characterised by extreme poverty and extreme disaster risk. People in these areas use coastal resources for their livelihoods and to provide protection from disasters. Comparisons of Concern's work across these three different contexts can therefore provide insights into how to reduce disaster risk in coastal regions.

**Preparedness** includes reducing emergency response time by increasing access, contingency planning, and linking communities to early warning systems (EWS), which, in these cases, are for cyclones/hurricanes. Access may be further improved by providing boats rather than just improving roads, as not all coastal areas are best reached by land. Not all people receive early warnings in spite of concerted efforts to make this so. The 'last mile' in EWS communication strategies often proves to be the most challenging. Communication systems must use multiple methods, both modern and traditional, in order to reach all vulnerable people.

Linking people to EWS is only part of the challenge for early warnings. As important is building trust in the system, so that vulnerable people believe warnings when they are issued, are prepared to seek shelter, maintain a safe and secure shelter space, and safeguard livelihood assets while in the shelter. Preparedness and contingency planning needs to be short and succinct for everyone to understand what they should do – being overly prescriptive or detailed risks losing some people from the process.



The aftermath of disasters can be a window of opportunity for DRR since willingness to improve preparedness is often high. This should also be used for building back better. There are insufficient storm shelters in all cases, so people must resort to using schools or homes that are not designed for use as storm shelters. Designing new buildings (such as rebuilt schools or even homes) to act as extra storm shelters would help reduce cyclone/hurricane risk in coastal areas. However, it is also imperative that the original functionality of such buildings is not compromised when used as shelters. Children, for example, need to be able to quickly return back to school following hurricanes.

**Natural resource management** involves using natural resources for reducing the scale, intensity or frequency of hazards. It is often developed in conjunction with livelihood interventions and water resource improvements. Concern has had little success in planting trees and grasses for reducing coastal erosion or storm surge intensity, in spite of natural forest stands being effective in this. Conservation of existing natural coastal forests, especially mangroves, pays more dividends than reforestation, and is suggested as a priority coastal DRR activity.

Certain coastal livelihoods, like forest resource use and shrimp farming, degrade natural resources, and salinisation makes other livelihoods challenging. Coastal area DRR requires integrated interventions aimed at offering alternative livelihoods that are more hazard resilient and environmentally benign, and that include a mix of natural resource management and structural measures such as ponds and embankments.

**Structural measures** include ensuring that existing and new infrastructure is hazard proofed, and building structures (such as embankments) that are focused specifically on providing protection to certain hazards. Engineering challenges can be considerable given the forces unleashed by cyclones/hurricane. Building structures to withstand these hazards can be costly, but is necessary to reduce risk.


In areas where population density is high there are few alternatives to pursuing engineering solutions combined with natural resource management and preparedness, but in areas with lower population pressure, relocation of vulnerable people away from high risk zones could also be considered, but this is a highly contentious strategy which comes with its own risks, and should be treated with extreme caution.

The best approaches to DRR in coastal areas are ones that combine preparedness, natural resource management, livelihoods improvements, water resource management and structural measures. These interventions involve disparate stakeholders at multiple levels.

For an integrated approach to be successful in coastal areas, with a multitude of competing interests and stakeholders, it must be underpinned and supported by robust multi-stakeholder representative platforms working at different scales and administrative levels.

This study identifies a number of lessons learned:

- Coastal areas are dynamic and constantly changing. Coastal DRR ought to adapt accordingly.
- Despite a number of commonalities, coastal areas also display substantial variety in terms of their hazards, vulnerabilities, and capacities. This variety must be identified and understood through proper analysis.
- Coastal DRR is best approached with a combination of methods spanning sectors and actors.

- 
- Although cyclones can cause the most deaths, communities often identify erosion as a primary hazard. Efforts should be made to reduce erosion, and any coastal DRR should include participatory risk assessments to capture risks that communities deem important.
  - Preparedness can save lives and resources.
  - Structural measures, natural resource management, and preparedness are effective in reducing coastal risk and should be used in conjunction with each other.
  - The implications of risk creation and reduction should be assessed beyond the immediate local context. They should be viewed at meso and macro levels (vertically) and across other areas (horizontal). For example, forests can span state boundaries, requiring trans-boundary approaches to management, and also require local populations to change behaviour.
  - Certain DRR interventions can have detrimental knock-on effects. Crime and other acts of violence can sometimes occur during evacuation and in shelters. Protection should be assessed to see whether it needs inclusion as an element of EWS.
  - DRR is important for all interventions and risk should not just be reduced to stand-alone activities.

While this report outlines challenges and approaches specific to coastal areas some underlying causes of coastal vulnerabilities, capacities, and hazards, as well as methods of coastal DRR, are not unique to coastal areas. Many approaches can be applied. Indeed, coastal contexts are like many other contexts in that the challenges they face are a complex product of poverty, vulnerability, inequality, and hazards, meaning that general DRR principles and practices also hold true and should be adapted rather than discarded for DRR in coastal contexts.

# 1. Introduction

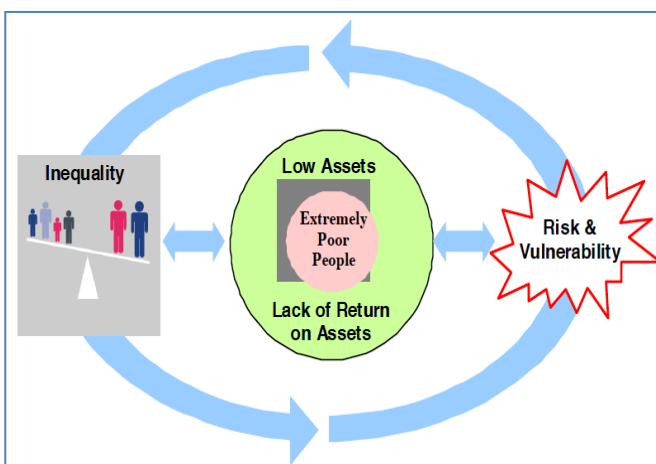
Managing disaster risk in coastal areas is a vital component of sustainable coastal development. 123 countries have coastlines, coastal areas comprise 20 percent of the Earth's surface, and over 50 percent of the world's population lives within 100 kilometres of the coast (Chua *et al.*, 2006). Those living in coastal areas are exposed to a number of hazards, from large-scale cyclones, hurricanes or typhoons, to tsunamis and smaller scale disasters like environmental degradation and disease. Typhoon Haiyan is a reminder of just how strong coastal disasters can be: the 2013 storm killed 6,268 people in the Philippines alone and created an estimated \$14.5 billion in damages. While coastal disasters can be extreme, they are not, however, inevitable. They are created by human interactions with their environments, characteristic of the societies within which they occur (Berton *et al.*, 1978; Albala-Bertrand 2000; Cannon, 1994; Hewitt, 1997). As such, it is possible to reduce risks in coastal area with the right social practices, approaches, and tools.

This report documents how Concern Worldwide uses disaster risk reduction (DRR)<sup>1</sup> to reduce risk and build resilience of the poorest and most vulnerable people living in coastal areas.

Concern Worldwide is a non-governmental, international, humanitarian organisation dedicated to the reduction of suffering and working towards the ultimate elimination of extreme poverty in the world's poorest and most vulnerable countries. Operating in over 25 countries around the world, Concern Worldwide adopts a multidimensional approach to addressing extreme poverty and responds to humanitarian emergencies when the community capacity to cope and recover from crisis are overwhelmed. The organisation uses its knowledge and experience to influence decisions made at a local, national and international level to significantly reduce extreme poverty.

This report is based on the past decade of Concern's DRR programming experience in coastal contexts.

The lack of, or low returns from assets defines poverty and is caused and maintained by inequality and risk and vulnerability. These three dimensions of poverty are conceptualised in figure 1.



Concern's understanding of DRR, first articulated in 2005, identifies four components; risk analysis<sup>2</sup>, preparedness, mitigation, and advocacy, which together build community resilience.

This report is based on the past decade of Concern's DRR programming experience in coastal contexts.

Figure 1: How Concern understands extreme poverty (from Concern, 2010)





## **Methods of comparison and structure of the report**

To develop an understanding of how Concern reduces risk in coastal areas, this report systematically compares, assesses, and reviews Concern's DRR activities in three coastal areas: the island of La Gonâve, located off the coast of Port au Prince in Haiti; the Sunderban coastal areas of Bangladesh, bordering India; and the Chinde district in the Zambezia province of Mozambique. These three areas, while all coastal, are also exposed to different constellations of risks. Comparing them therefore provides a means of developing an understanding of good practices on coastal DRR. To facilitate such comparison, this report has been divided into four sections:

- The first section introduces the concept of coastal risk and coastal DRR.
- The second presents and compares each case to identify DRR activities common to coastal areas.
- The third reviews each activity in detail and develops lessons learned.
- The last section concludes with overall lessons for DRR in coastal contexts.

This structure builds an understanding of Concern's approach to DRR in mountain areas from the activities of the organisation itself. It is based on a series of 2-4 week country visits (Haiti in August, 2013; Bangladesh in August, 2014; and Mozambique in September, 2014), consisting of focus group discussions and key informant interviews of Concern staff, partners, and beneficiaries and collection and review of secondary data.

## 2. Coastal areas and diastar risk reduction

It is generally understood that a coastal area is a place where the ocean meets the land, however there is a wide variety of definitions of what specifically constitutes a coastal area. Some define coastal areas based on their administrative boundaries, others on their economic, ecological, or cultural characteristics (UNESCO, n.d). Because of this lack of conceptual clarity, the FAO (Clark *et al.*, 1992) suggests a pragmatic approach of defining coastal areas based on the issue at hand. Taking this approach, a coastal area should therefore be defined from a disaster risk perspective by the elements of risk - the hazards, vulnerabilities, and capacities - created when the ocean meets the land. Table 1 provides an overview of the elements of disaster risk and their corresponding coastal attributes.

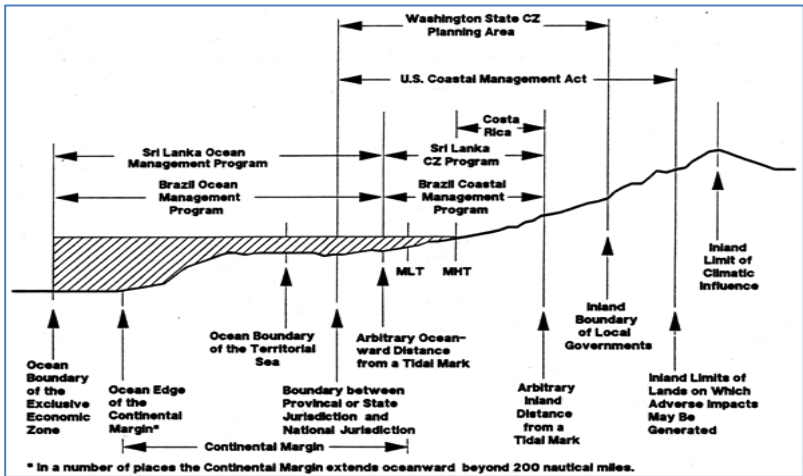


Figure 2 shows some of the various ways of demarcating a coastal area, showing how varied the interpretations of coastal areas are (Clark *et al.*, 1992)

Element of risk	Coastal attribute
<b>Hazard</b>	Exposure to common ocean derived hazards like storm surges and ocean based erosion
<b>Vulnerability</b>	Common coastal vulnerabilities including high population densities, multitude of policy bodies
<b>Capacity</b>	Access to common coastal resources including fisheries, trade routes, mitigation knowledge, and mangroves

Table 1: elements of disaster risk and their coastal attributes

This definition produces a graduated view of coastal areas. An area may, for example, have a coastal economy but not be exposed to coastal hazards. Equally, it might be exposed to coastal hazards but have few coastal vulnerabilities. For example, the land surrounding large freshwater lakes might not fall under the category of a coastal area, as it is not an area where the ocean meets the land, but there might be coastal hazards, vulnerabilities, and capacities. The definition is in line with DRR literature that emphasises risk as a complex mix of hazards, vulnerability, and capacity and the coastal management literature that stresses that coastal management should focus on coastal *areas* (the area of interaction between land and ocean), not *coastlines* (the precise boundary between land and ocean).

## Coastal hazards, vulnerabilities, capacities, and risk reduction

Humanity is concentrated within coastal areas because of the resources that those areas provide. Coastal ecosystems are extremely food productive, can offer protection against storms and floods, can help maintain water quality, and can support tourism and provide other cultural benefits (UNEP, 2006). Coastal areas are often key trade locations that support ocean-based trade, and indeed many cities have grown around deep-water ports (McGranahan *et al.*, 2007). Coastal risk reduction is about utilising the capacities that coastal areas provide in a sustainable way that also reduces risk.

A number of hazards are produced when the ocean and land meet. Some common ones include **tsunami**, **storm surges**, **cyclones/hurricanes/typhoons**, **salinisation** and **coastal erosion**. **Climate change** is exacerbating these hazards.

A **tsunami** is a water wave caused by the forcible displacement of a large body of water. When these waves touch land they can cause coastal flooding and create massive and widespread destruction. Earthquakes are responsible for 80 per cent of the world's tsunamis, so the seismically active Pacific and Indian Ocean areas are the source of most tsunamis (see Figure 3). Tsunamis can also be caused by landslides, meteorites, and even nuclear detonations, meaning all coastal areas have some exposure to tsunamis.

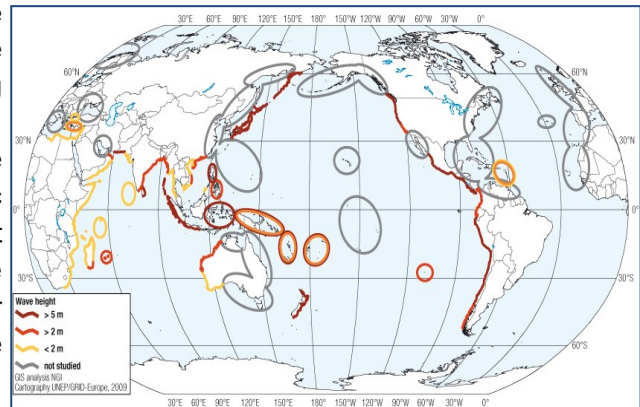


Figure 3: global tsunami risk

A **cyclone** (known as a tropical storm and as a hurricane in North America and a typhoon in Asia) is a specific type of storm characterised by a low-pressure centre, strong winds, and a spiral arrangement of thunderstorms that produce heavy rain. Cyclones form over oceans at least 450 km away from the equator, in waters whose temperatures are above 27 °C for 50 meters depth, and when a minimum wind speed threshold is reached. This means that they only form in certain locations at certain times of the year. Cyclones can create massive storm surges that can damage coastal areas. Their winds can also directly damage buildings and other infrastructure.

A **storm surge** is a rise in water level above normal caused by a storm. Storm surges are wind driven and occur when wind speeds are high. They can happen in any coastal area and are exacerbated during periods of high tides. Storm surges create coastal flooding and can contribute to erosion.

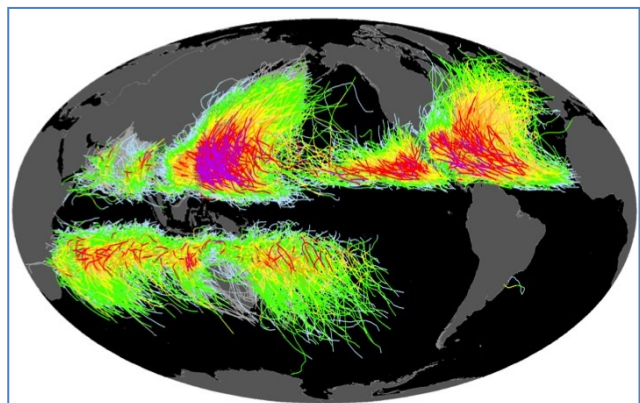



Figure 4: map of cyclones from 1970-2008 (NOAA, 2010). The map can help serve as a rough guide for areas at risk of cyclones.



**Coastal erosion** is the removal of coastal land by the ocean. There are two types of coastal erosion: *dune erosion*, a short-term removal of sand from an area, and *structural erosion*, a long-term removal of a part of the coast. Dune erosion is a natural response to ocean forces and reflects the dynamic nature of coastal areas. It does not cause permanent damage to coastal areas, but simply removes and relocates sands to a new region. *Structural erosion*, on the other hand, causes long term changes in the coastline, reduces the asset bases of coastal areas, and leaves those areas vulnerable to other coastal risks (Cooper and McKenna, 2008). Natural factors like strong winds, high tides, and storm surges all contribute to coastal erosion, as do manmade factors like the construction of coastal structures that interfere with the natural transport of sediments along the coastline and the destruction of protective ecosystems like coastal wetlands and mangroves.

**Climate change** is having a drastic impact on coastal areas. Sea levels are rising as polar ice caps melt, threatening low-lying coastal areas. This can express itself as the intrusion of saline water into fresh groundwater sources. This is known as **salinisation** (salinisation can also be caused by storm surges). Climate change is also creating increasingly erratic and intense weather patterns, placing strain on coastal ecosystems and increasing the prevalence of extreme weather events such as cyclones and storm surges. Small islands in the Pacific and Indian oceans and in the Caribbean as well as Asian and African coastal areas are particularly at risk of the effects of climate change (Nicholls *et al.*, 2010).

Natural disasters caused by coastal hazards can lead to **technological disasters**. The 2011 Tohoku earthquake and tsunami led to three reactor failures at the Fukushima nuclear power plant in Japan, which caused the evacuation of hundreds of thousands of people (CNN, 2015). When Hurricane Katrina hit New Orleans in 2005, 80% of the city was flooded. Most of the flooding was caused not by the hurricane itself but rather by the widespread failure of hurricane surge protection structures throughout the city (Van Heerden, 2007).nature, which is to be reduced through social changes.

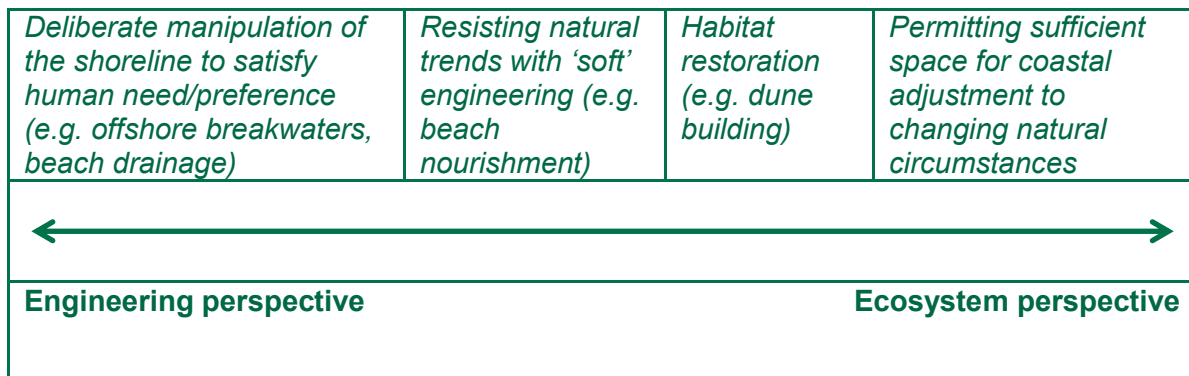
The focus on controlling and separating hazards from humanity often involves large scale investment in the scientific monitoring and prediction of hazards; planning and managerial activities to contain hazards with engineering or forceful human management; and responding to disasters through the provision of emergency relief (Hewitt, 1980). In coastal areas this might involve developing large-scale engineering structures such as levees and imposing strong regulations on where populations can settle. These interventions are delivered in a top down manner, mainly carried out by experts specialising in understanding and controlling systems of people and nature. Although such interventions can help reduce disaster risk, when they fail they can also cause great damage - as the surge protection failures in New Orleans demonstrated.

Coastal DRR is increasingly being approached through the vulnerability paradigm. Integrated Coastal Zone Management (ICZM), a process promoting the coordinated development and management of coastal and related resources for sustainable development, and ecosystem DRR, the management of ecosystems as a mechanism for reducing disaster risk, are both examples of such approaches. Both view coastal DRR as requiring an examination of the interlinking natural and human systems at micro, meso, and macro levels, and focus on balancing natural and social systems (Moser *et al.*, 2012; Gupta and Nair, 2012; Renaud *et al.*, 2013). Community based DRR is another example, as it recognises local populations to have agency in risk and risk reduction and seeks to reduce risks that they deem important. Although somewhat a new policy and practitioner paradigm, having gained acceptance only in the past 20 years, such approaches to coastal management are not new within society. Maine lobster fishermen, for example, practiced a socio-ecological form of managing lobster resources for generations in a way that has helped maintain lobster fishing as a viable livelihood activity (Acheson, 1988).



Ecosystem and engineering approaches should be thought of as two ends of a spectrum (figure 5) within which any number of interventions might fall:

While engineering approaches tend to relate to the hazard paradigm and ecosystem approaches to the vulnerability paradigm, these techniques are not limited to either paradigm but can be used for both.



*Figure 5: approaches to coastal interventions (from Cooper and McKenna, 2008)*

### 3. Overview of the coastal case studies and Concern

Concern works to eliminate extreme poverty in the coastal areas of La Gonâve in Haiti; the Sunderbans in Bangladesh; and Chinde district of Mozambique. In all these areas it includes DRR as part of its activities.


#### La Gonâve, Haiti

Port au Prince is the capital of Haiti, and La Gonâve is a small island within the city's administrative boundaries and located off its coast. The island is a dryland tropical agro-pastoral zone, exposed to coastal hazards including hurricanes, storm surges, erosion, and tsunamis. It also experiences numerous other non-coastal hazards including landslides, earthquakes, drought, floods, and disease including cholera and HIV/AIDS. Hurricanes occur frequently and have a large impact on the 80,000 people living on the island: beneficiaries are, for example, recovering from Hurricane Sandy, which caused \$750 million in damage and left around 200,000 people homeless across the country in 2012.

La Gonâve has high rates of poverty compared to the rest of the Port Au Prince municipality: 89% of the island's population lives on less than \$2 per day and 53% live on \$0.15 per day or less. The island is mainly rural and most of the extreme poor live in remote settlements away from the social, economic, and political resources of the capital. They mainly engage in subsistence agriculture, fishing, and charcoal production for their livelihoods. These settlements are often very hazard-prone, exposed to coastal storms and suffering from water scarcity - it is common to walk three hours or more to collect water from poor springs (Evans, 2014). Environmental degradation on the island is extreme, and fisheries, forests, and agricultural land are often very depleted.



*The coastline of La Gonâve. Note the houses on the hill, constructed with the help of Concern. Much of the area is scrubland, and is used mainly for charcoal production.*



The state has a disaster management system, but it faces challenges, especially when it comes to implementing local level DRR activities. The government is a signatory to the 2005 Hyogo Framework for Action (HFA), the international policy commitment on DRR. Its HFA mid-term reviews produced an overall score of 2.33 falling between 2 (DRR progress has been made to a very limited extent) and 3 (some activity but significant room for improvement), with the weakest score of 1.67 on reducing underlying risk factors (Baptiste, 2013). Many DRR policies are in place but there are gaps in implementation to the extent that many individuals and households rely on each other to reduce risk or the services of NGOs.

Concern works across La Gonâve and has implemented a number of projects related to water, sanitation and hygiene (WASH), with a major focus on improving water supplies; health; and livelihoods; and has specific DRR interventions focused on strengthening community disaster management committees, natural resource management, and shelter support and other forms of small scale structural mitigation. Concern also responds to emergencies when necessary, including large-scale responses to the earthquake of 2010 and the hurricanes of 2012. It implements activities directly, but also works to strengthen the DRR capacities of government and community stakeholders.

## The Sunderban areas of Bangladesh

Around 20 percent of Bangladesh's land is coastal, and those areas, like the coastal areas of Haiti, are exposed to coastal hazards, which include cyclones, storm surges, erosion, tsunami, and salinisation of water. Cyclones in 1970 left 300,000 dead, and those in 2007 and 2009 each killed approximately 5,000 (CRED, 2015). People living in these areas also face non-coastal hazards, notably drought and disease. Climate change is having severe effects on the area: sea levels have risen an estimated 3.2 mm per year for the last 20 years, threatening lands, increasing water scarcity, compromising livelihoods, and increasing weather related risks (Church *et al.*, 2013).

Concern works in the Sunderban region in Bangladesh. The region is located in the southwest of the country and is home to four million people. The Sunderbans are the largest mangroves in the world; they are a biodiversity hotspot, offer protection from storm surges, hurricanes, and erosion, are used as a supplementary livelihood income, and are a very effective carbon dioxide sink (Brander *et al.*, 2012). While the Sunderban ecosystem provides a host of services, it is being increasingly strained due to increasing human use (Rahman *et al.*, 2010). Additionally, government and non-governmental services are weak and poverty is acute, with most beneficiaries engaging in subsistence agriculture, fishing, and petty trade for their livelihoods (around 80% of the population is dependent on sectors connected to coastal areas for primary production) in a similar fashion to those who live in La Gonâve. Poverty is, furthermore, growing since Cyclone Aila hit the region in 2009. The cyclone destroyed physical infrastructure and, more devastatingly, inundating and salinising vast areas of agricultural lands and fresh water resources.

Communities living in the Sunderbans have strategies to mitigate coastal risk. They often modify their livelihoods to take advantage of coastal resources, use natural and social structures to recover from disasters, and construct shelters that are resistant to coastal hazards and are easy to repair. For example, they construct buildings on stilts or raised platforms to reduce exposure to storm surges; they plant crops in accordance with growing seasons; and they use Sunderban resources as an emergency source of income following disasters. Despite these efforts, disasters still have a large effect on the region's population, and many consider risk to be growing because of the increasing environmental degradation of the area, much of it caused by increasing human activity from users themselves.



*A village in the Sunderban area of Bangladesh. Houses are frequently located next to the shore line and exposed to numerous coastal hazards.*

The government of Bangladesh has a disaster management system in place and has been shifting over the past few years toward more preventative risk management approaches increasingly focused on DRR. The state is a signatory to the 2005 HFA. Its 2011 mid-term review score was 3.72, falling between 3 (some activity but significant room for improvement) and 4 (substantial progress) (Zakir, 2011). In coastal areas, it has a focus on improving preparedness and has been working to develop a comprehensive preparedness and early warning system that includes the provision of high quality storm shelters. However, there are still gaps in coverage, particularly in the poorer and more remote parts of the region.

Concern has been working in Bangladesh since 1973, and started working in the Sunderbans in 2009. The organisation focuses on improving livelihoods, reducing risk, and adapting to the effects of climate change including the protection of the Sunderban ecosystem. Much of its direct DRR work focuses on supporting local disaster management systems, small-scale mitigation, improving preparedness, and promoting environmental sustainability. Bangladesh has a strong civil society and Concern works through national NGO partners in all of its programmes.



## The Chinde District of the Zambezia Province of Mozambique

The 16,000 residents of the Chinde District of Mozambique face a number of coastal risks including cyclones, storm surges, and coastal erosion. They also experience riverine flooding and erosion, drought, and human and agricultural diseases, including HIV/AIDS, malaria, and water borne diseases. Poverty is endemic in the district: the district itself is located in Zambezia province, the poorest province in the country, with 70% of households living in poverty. Many of the poor live in isolated areas far from services, markets, and sources of political power, and receive only limited support from external actors including government agencies and NGOs.

Communities living in the province have developed a number of mechanisms to reduce risk. They plant seasonally appropriate crops, taking advantage of cyclical weather patterns. Land, forests, and fisheries are plentiful and many rely on them for livelihoods. They also have systems to manage risk such as customary early warning systems - one resident said they knew that if a certain plant did not flower, a drought was likely to occur - and community support structures - beneficiaries will provide support to each other when in need, often regardless of kinship connections (Concern, 2012).

The government of Mozambique has a disaster management structure focused on risk reduction and emergency response designed to be operational at all levels, from local to national, and across all departments. As with the other cases, its policy is well formulated, but there are certain gaps in implementation, particularly at lower levels. Its 2013 HFA mid term review score of 3.11 shows some progress is being made but with some indicator scores still low, particularly when it comes to strengthening preparedness, which only received a score of 2 (Abreau, 2013).



*A boat on the Zambezi River near Chinde, a remote town that is only accessible by boat or motorbike (Photo: Crystal Wells, 2014)*

Concern has been working in Mozambique since 1987, and in the Chinde district since 2005. It focuses mainly on livelihoods and emergency response, with minor activities in other areas. DRR is considered a crosscutting issue and is mainstreamed across programmes, including the livelihoods programme. Most of Concern's direct DRR work focuses on developing the government disaster management system, including creating and supporting disaster management committees, small-scale structural and non-structural mitigation, strengthening flood and cyclone early warning systems, and relocating residents from high to low risk areas.

The coastal areas of Haiti, Bangladesh, and Mozambique share certain characteristics in terms of their poverty and risk profiles. Nonetheless, there are also some key differences.

## Discussion

The coastal areas of Haiti, Bangladesh, and Mozambique share certain characteristics in terms of their poverty and risk profiles. Nonetheless, there are also some key differences.

From a hazard perspective, the three areas face coastal hazards related to erosion, cyclones/hurricanes, storm surges, and tsunamis, as well as other hazards including disease and drought. Vulnerabilities and capacities are also coastal in the sense that many use coastal areas for their livelihoods, the sea and rivers for transportation, and ecosystems for services including protection from hazards and as a source of food, fuel, and income. Risk is also shaped by non-coastal vulnerabilities including extreme rates of poverty, isolation, and few services, including those related to DRR.



*Livelihoods are 'coastal' in all areas. In Haiti (left) residents work in charcoal production (foreground), which they ship via boat to Port au Prince. Fishing is a common livelihood activity in Bangladesh (right).*

Some differences can also be seen between areas. HIV/AIDS is much more prevalent in Mozambique and Haiti than in Bangladesh, and earthquakes are much more of a threat in Haiti and eastern Bangladesh than Mozambique. Environmental degradation, likewise, is substantial in La Gonâve, while in Bangladesh and Mozambique it is occurring but at less extensive rates. Land resources also differ, with land being plentiful in Mozambique - most people, including the poorer ones, own land - while in Bangladesh and Haiti, land ownership amongst the poor is uncommon, and the poor mainly live on marginal land that they rent. The DRR structures also show some differences, with Bangladesh's DRR structures more developed than Mozambique's, which are in turn more developed than Haiti's. This is reflected in the countries' respective HFA mid-term review scores of 3.72, 3.11, and 2.33. Overall, these differences in hazards, vulnerabilities, and capacities contribute to the range of risk profiles across the areas.

The following lessons can be learned from comparing these coastal contexts:

- Coastal contexts have specific risks including cyclones/hurricanes, coastal erosion, tsunamis, and storm surges.
- Non-coastal risks can be found in coastal areas.
- Coastal disasters such as salinisation can affect lives, livelihoods, and property and can change social structures.
- Even small hazards can affect a large number of people in densely populated coastal areas.
- People living in coastal areas often engage in activities to reduce coastal risk by taking advantage of the coastal environmental and social resources.
- While government policies might be developed to reduce coastal risk, the poor living in coastal areas are often underserved by existing governmental DRR structures.



*In each case residents have strategies in place to manage coastal risk. The picture on the left was taken in the Sundarbans. It shows a mud embankment with some concrete blocks for basic protection. The image on the right is of a shell and wood embankment that residents of La Gonâve have constructed to protect from erosion*

## 4. Concern's approach to disaster risk reduction in coastal areas

Concern has documented its approach to DRR in a series of policy and guidance papers. These include *Approaches to DRR* (Concern, 2005) and *Risk Analysis Guidelines* (Concern, 2012).

Concern uses risk analysis as a first step to better understand the hazards and vulnerability that communities face, and inform where Concern can reduce the scale, intensity and frequency of events whilst addressing both general and specific vulnerabilities within the community.

Concern has adopted a broad understanding of hazards that includes human derived hazards (e.g. conflict) and natural hazards (e.g. floods) and their often complex interactions. Concern places equal emphasis on intensive risk (large events happening in areas of dense population or economic activity) and extensive risk (small, localised but very frequent events that are highly erosive to livelihoods and keep people poor). Concern understands that risk can affect all sectors and interventions, and so mainstreams DRR across all sectors and programmes<sup>3</sup> by ensuring that risk analysis is central to the design of all interventions, in addition to running selected stand-alone programmes. Concern takes an explicit **community focus** centred on individuals, households, and communities.

Whatever the context, Concern takes an integrated and holistic approach to DRR that capitalises on and strengthens the asset base of communities. Risk is reduced through various activities including structural measures, supporting early warning systems, building up livelihoods assets, and strengthening governmental or community DRR institutions.

Lastly, to ensure interventions actually achieve what they are designed for and to learn how to improve and build upon its work, Concern **measures interventions** with baseline and endline surveys, evaluations, and other studies.

Concern engages in the following DRR methods to address the coastal specific risks (tsunami, storm and tidal surges, cyclones/hurricanes, and coastal erosion) in these three cases:

### Common DRR activities


- Participatory risk analysis
- Contextual analysis
- Supporting early warning systems
- Building organisational preparedness
- Supporting community preparedness
- Local capacity building of community disaster management committees
- Improving transportation
- Building livelihoods

## Common DRR activities continued

- Improving water points
- Constructing storm shelters, roads, and embankments to reduce risk
- Forestry management
- Sustainable agriculture
- Baseline and endline surveys
- One-off studies

## Unique DRR activities

- Household preparedness ( Bangladesh)
- Household structural mitigation ( Bangladesh)
- Resettlement from high to low risk areas ( Mozambique)
- First response training ( Haiti)
- Prepositioning stocks ( Haiti and Mozambique)
- Supporting health and education ( Haiti and Bangladesh)
- Building committees to manage natural resources ( Haiti and Bangladesh)
- Managing fisheries ( Haiti)
- Climate change advocacy ( Bangladesh)
- Capacity building of national partners ( Mozambique)



The interventions can be generally sorted under a broad typology. Some, like prepositioning stocks, developing early warning systems, and building the capacity of disaster management committees can be classified as **preparedness**. Sustainable agriculture, forestry and fisheries management, and climate change actions are interventions broadly focused on the environment, and fall under the category of **natural resource management (NRM)**. Construction work including shelters, roads, embankments, and houses are all **structural measures**. The following definitions are provided for preparedness, NRM, and structure measures:

### **Preparedness**

The UNISDR (2009) defines preparedness as “the knowledge and capacities developed by governments, professional response and recovery organisations, communities and individuals to effectively anticipate, respond to, and recover from, the impacts of likely, imminent or current hazard events or conditions”. Any of Concern’s interventions that support response –like prepositioning stocks, improving transportation, and supporting early warning systems—can be considered preparedness.

### **Natural resource management (NRM)**

NRM is “the sustainable utilization of major natural resources, such as land, water, air, minerals, forests, fisheries, and wild flora and fauna” (World Bank, 2000). In coastal contexts Concern uses NRM for vulnerability and hazard mitigation, with activities ranging from supporting livelihoods, developing forest committees, and improving water management.

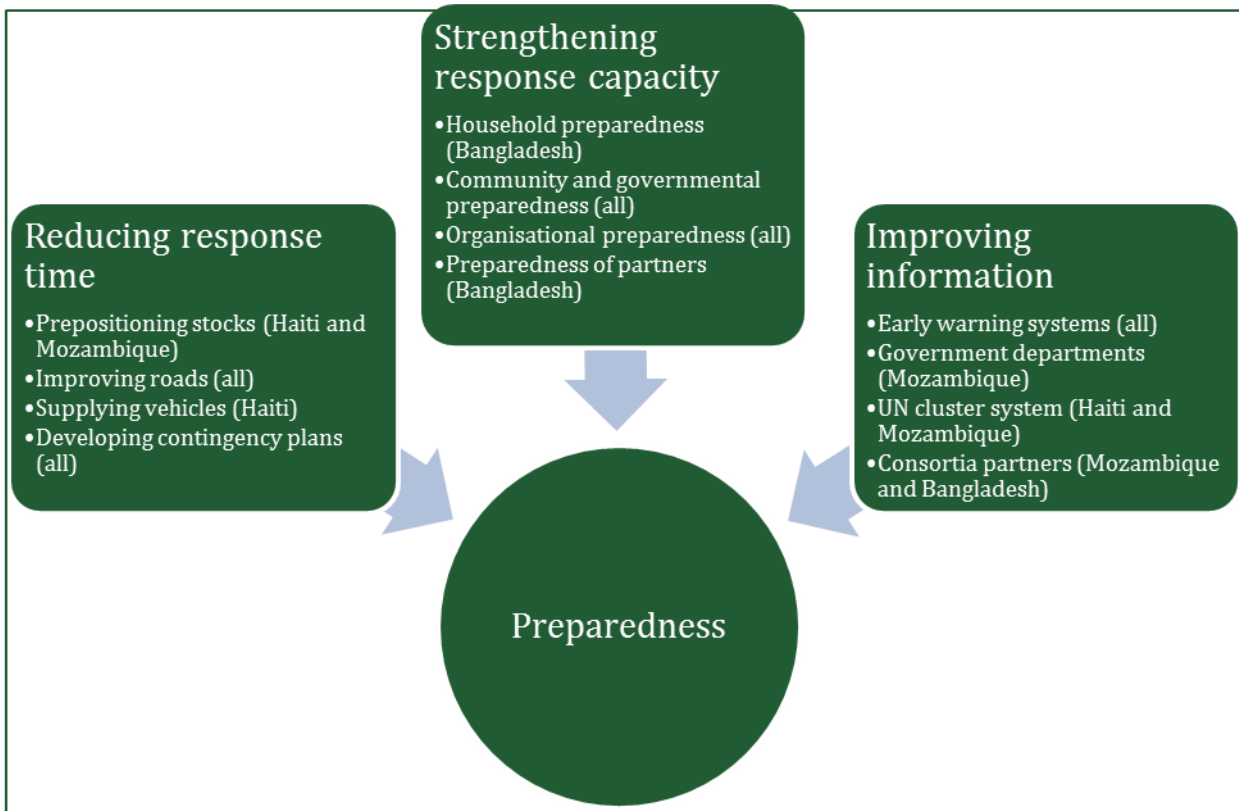
### **Structural measures**

Structural measures are “any physical construction to reduce or avoid possible impacts of hazards, or application of engineering techniques to achieve hazard resistance and resilience in structures or systems” (UNISDR, 2009). Like NRM, Concern implements structural measures as a form of risk mitigation.

The next section reviews these activities in detail.

## Preparedness

Disasters can always occur, so planning and preparing to respond to them is a necessary component of DRR in every context, including coastal ones. Concern prepares for disasters in all countries in which it operates, including Haiti, Mozambique, and Bangladesh. To prepare for disasters Concern focuses on improving the ability of the community members to survive and cope during a disaster, of all stakeholders to respond to disasters (strengthening response capacity), the flow of information before and during emergencies (improving information), and the speed in which life-saving goods can be supplied (reducing response time). In this way Concern helps ensure the right goods quickly reach those in need in an efficient manner. Figure 6 shows the specific activities within these categories:



*Figure 6: Core components of preparedness in coastal contexts*

## Strengthening response capacity

Everyone has a role in disaster response, so Concern works to improve the disaster response ability of all stakeholders. Its activities include emergency response training, developing contingency plans, and providing response materials and funds.

In Bangladesh, Concern works to improve household coping and response capacity before, during, and after floods and storms by helping households to develop and implement their own household level preparedness plans. Households develop the plans themselves based on their vulnerabilities and capacities. These include specific instructions for each household member: younger and stronger members of the family might assist elderly or disabled members in evacuation, for example. While specifics vary between households, households often develop a set of common actions such as reinforcing walls, raising foundations, and tying down roofs of shelters to reduce flood and storm risk; preparing a supply of key goods for use during emergencies; and outlining post-disaster recovery processes including households repairs and re-establishing livelihoods. Each household outlines their plan in the front few pages of their financial ledger, a prominent place that helps ensure future use.

In Haiti, Mozambique, and Bangladesh Concern works to build community-level preparedness by developing local governmental disaster management committees (DMCs) and supporting them in implementing preparedness activities. Within each country, local DMCs are made up of volunteers from the community so Concern's support strengthens both government and community preparedness. When they are available, e.g. in Haiti and Mozambique but not in Bangladesh, Concern follows the guidelines set out in government policy for developing these committees. This means that in Mozambique and Haiti committees are democratically elected and tend to be comprised of key leaders in the community, while in Bangladesh they are comprised of poor and vulnerable beneficiaries engaged in Concern's other projects.

As part of establishing committees Concern provides basic training on how to assess, prepare, and mitigate risk, including issues related to committee governance and coordination. These issues cut across contexts but are made specific for the coastal areas. This includes mitigation and preparedness for coastal specific hazards like flooding and cyclones as well as how to respond in coastal areas that might be cut off by the ocean during storms and other events. In Haiti, Concern provides first aid and search and rescue training to DMCs, which they can use for response. Such training is useful as the communities can often become isolated during emergencies, such as when storms make ocean travel impossible.



*A household level preparedness basket in Bangladesh. The basket includes key goods and documents necessary for after a disaster.*



While Concern's preparedness activities in Bangladesh are focused on the household level, its preparedness activities in Mozambique focus on the community level. In Mozambique, Concern has helped DMCs store grain in siloes in an equivalent way that households store grain in Bangladesh, to be used as post-disaster recovery. Concern has also engaged in contingency planning at community and governmental levels including developing supplies and activities.


As a humanitarian organisation Concern will also respond to disasters if the community capacity to cope and recover is overwhelmed. Concern prepares for emergency responses through the *Preparedness for Effective Emergency Response* (PEER) process across all of its country programmes. PEER is an obligatory annual planning process reflecting the dynamic and changing nature of disaster events and response. PEER has three goals:

- to reiterate and reinforce the humanitarian nature of the organisation and the obligation to respond,
- to ensure that hazards and the humanitarian context are continuously monitored and engaged with, and
- to ensure that there is sufficient capacity at all times to mount an effective and timely emergency response

There are a number of funds that can be accessed by all country programmes for emergency response. Irish Aid has the Emergency Response Fund Scheme where €400,000 is allocated annually for initial funding to rapid onset emergencies. Concern can also apply for funding for emergency responses from DFID's Rapid Response Facility and the START fund.



**Bridges, roads, and paths can be key for response. They need to be constructed based on the local risk profile. The three pictures above show three different bridges constructed with Concern's support. On the left is a bridge in Mozambique constructed by disaster management committees, connecting a village located on low land to higher land, allowing them to escape to safety during storms. The right two pictures show two bridges in Haiti. The bridge in the middle constructed by DMCs and connects a village in a low-lying area to higher land, while the bridge on the far right was constructed by Concern to connect one half of the island to the other to be used to deliver goods during emergencies.**



Concern also has an internal funding mechanism, the Chief Executive Officer Fund, designed to provide immediate funding to allow large-scale rapid-onset emergency responses to be initiated while additional donor funding is being sought, or to fund responses to small-scale localised crises for which donor funding would be very difficult to access. Up to €250,000 can be accessed with the approval of the CEO.

Concern works through partners in Bangladesh and has supported them in strengthening their emergency preparedness. It has facilitated the PEER process for its national partners, and they have, in turn, produced their own contingency and PEER plans. On a biannual basis Concern also conducts preparedness training for partners to reinforce these planning processes. Concern staff state that the process is useful but that they do not have the financial or human resources to build preparedness to the level that they desire.

## Reducing response time

Concern adopts a number of means to deliver goods to places of need faster, including improving roads and paths (all countries), developing contingency plans (all countries), prepositioning stocks (Mozambique and Haiti) and supplying committees with vehicles (Haiti).

Roads and paths are important components of emergency response in coastal areas: people use them to escape from storms and flooded areas, and external agencies use them to supply life-saving goods to emergency affected areas. In Haiti, Mozambique, and Bangladesh coastal settlements often lack sufficient road infrastructure and can be cut off during storms. In each of the three countries, Concern has helped construct bridges to improve emergency response. In Bangladesh and Haiti it has constructed roads and paths - in Bangladesh by repairing and raising paths and roads to higher levels, and in Haiti by repairing roads damaged in previous storms. In Bangladesh, disaster management committees construct paths as part of Concern's smaller mitigation activities, while Concern's road rehabilitation is part of its larger emergency recovery work. In Bangladesh Concern uses locally sourced materials that can be secured without destroying the ecosystem and that are also locally repairable, which means that communities themselves can maintain them. In Haiti Concern sometimes uses locally sourced materials, and other times imported materials. Following the earthquake of 2010 and hurricane Sandy of 2012 importing materials was necessary because so many structures were damaged that it was not possible to source enough locally produced material for repairs.

In Haiti, Concern supplied local DMCs with a motorboat to use during emergencies. This boat allows committees to respond quickly to emergencies in a way that is more effective than using paths and roads, which can be slow at best and impassable at worst, and better than using local boats, which are often not able to navigate the ocean during storms. In Bangladesh, the government has its own rescue boats. Respondents, however, state that more are needed to improve coverage. Such boats are not available in Mozambique and residents instead rely on traditional dugout canoes for response. These are slow, small, and can capsize easily.

Contingency plans are a set of operating procedures designed to be followed when emergencies occur. In all locations Concern has developed its own contingency plans and has supported its partners in developing similar plans. This involves reformulating plans. In Bangladesh: some national partners already had plans but, with Concern's help, they were able to reduce them from over 100 pages to around 15, noting that the shorter plans were more useful and more likely to be used in responding to emergencies. In Mozambique, Concern helps district line departments to develop contingency plans through its support of the technical administrative council, a district-level government council comprised of representatives of various ministries responsible for mainstreaming DRR into their respective departments. Council representatives have developed plans for what to do in the event of cyclone and other large-scale sudden onset disasters, and to do so have included DRR as part of their departmental budgets.



*Traditional boats can be slow and dangerous in emergency settings, particularly during storms when the ocean is rough and when rapid emergency response is needed. Dugout canoes (top) are a main form of transportation in Mozambique. Dugout canoes and sailboats (bottom left) are common in Haiti. A mixture of sailboats and paddleboats (bottom right) are used in Bangladesh. Concern supplies boats for emergency response in Haiti.*

In Haiti and Mozambique Concern has prepositioned stocks available for response located in key strategic locations. The stocks are replenished on a regular basis and supplied with non-perishable materials necessary for response, including generators, building materials, and tarpaulins. Concern works in isolated areas in these countries, so prepositioning stocks can substantially reduce response time. In Bangladesh, staff noted that pre-positioned stocks might have utility, but stated that they do not have the funds to develop stockpiles.

*This is Concern's warehouse in the town of Chinde, Mozambique. It contains lifesaving goods that can be used in an emergency. Chinde is nearly a day's journey by road and water from the provincial capital, so prepositioning stocks helps Concern respond to disasters in this area more quickly.*



## Improving information

Information is key to preparedness. With the right information, stakeholders can respond to hazards quickly - sometimes to the extent that hazards do not become disasters. Likewise, a coordinated response can help stakeholders work in a way in which efforts are complementary and where there are no major gaps in response locations or goods provided. Rather than leave these information flows to chance, Concern develops early warning systems (EWS) as a preparedness activity, and coordinates responses with governmental and non-governmental stakeholders when disasters occur.

An early warning system can be defined as the capacity to generate and disseminate warning information that allows for timely preparedness and action (UNISDR, 2009). In Haiti, Mozambique, and Bangladesh, governments are working to establish cyclone/hurricane EWS, and Concern supports their work by providing training and material to local DMCs on EWS, mainly related to how to receive and disseminate warnings. The EWS structures differ between countries: in Bangladesh messages are communicated through traditional rickshaw megaphones and a flag system; in Mozambique messages are received by radio (cell phones have limited coverage) and communicated using drums and megaphones; and in Haiti messages are communicated using megaphones. All three countries have gaps in terms of hazards covered. None have dedicated tsunami, drought, or other hazard EWS.

*These pictures show two ways of communicating EWS in Bangladesh. The flag system is used throughout the coastal areas for storm alerts, with each flag corresponding to a level of alert (one flag indicates a storm in the Bay of Bengal, two flags show that the storm is heading in the general direction, and three flags indicate the storm is near and that it is time to evacuate). Loudspeaker systems on a rickshaw are used throughout the country as a village-level communication tool for spreading a variety of messages, including flood and storm EWS warnings.*



EWS response tends to be similar across areas. In all locations, DMCs describe awareness-raising as useful for convincing people to follow EWS warnings. They also state that people tend to respond to EWS warnings better immediately following larger-scale disasters, as they are more fearful of the effects of disasters. Nonetheless, they also state that some are reticent to leave their homes in response to warnings, mainly because they want to protect their livelihoods and other valuable assets or because there are no shelters to go to. In Bangladesh, for example, storm shelters remain limited despite government efforts to improve them. They can be overcrowded; located in areas that cannot be reached during high water; and crime can be high in the shelters. There are no dedicated storm shelters in the areas in Mozambique and Haiti in which Concern works. Communities instead have to relocate to higher ground or use their houses or other structures for protection. These forms of protection are very minimal, so storms can be extremely dangerous.



*In Mozambique, EWS messages are communicated from national level via solar powered radio to local disaster management committees, who then relay them to the broader community using megaphones, drums, and horns. An attendant mans the station from 9am-3pm, 7 days a week. This system is designed so that messages can be communicated between local and national levels within 72 hours. DMCs have conducted community sensitisation activities to help ensure communities are receptive to EWS messages and know how to respond.*

Concern works with consortia partners in Mozambique and Bangladesh, with the cluster system in Haiti and Mozambique, and within the government line ministries in Mozambique that are focused on coordinating response. Concern's work with these groups reflects the strengths and limitations of national-level coordination mechanisms: the cluster systems are strong in Haiti and Mozambique, with most international aid efforts being coordinated through clusters, while in Bangladesh and Mozambique strong consortia have evolved focused on preparedness, risk reduction, and emergency response.

### **Conclusion and lessons to be learned**

Concern's work goes far in building disaster preparedness in coastal areas. Few of the areas in which Concern is active had functioning disaster response systems before the organisation's arrival, with most response activities occurring on an *ad hoc* basis by households and communities themselves with some support from the national government. By building response capacity, reducing response time, and improving coordination these preparedness activities have helped to establish a preparedness system. Furthermore, the work has been designed to promote and support government systems, making it sustainable in the longer term. Table 2 shows the impact of Concern's work in building preparedness:


	Response time	Information	Capacity	Overall
Haiti	L → M	L → M	L → M	L → M
Mozambique	L → H	L → H	L → M	L → M
Bangladesh	L → M	M → H	M → H	M → H
Overall	<i>Roads improved</i>  <i>Prepositioning stocks useful</i>  <i>Local level response is first</i>	<i>Strong EWS for storms, cyclone</i>  <i>Gaps in EWS response</i>  <i>Lack of multi-hazard EWS</i>	<i>Improved community governance, planning</i>  <i>Still too few boats for response</i>  <i>Financial limitations hinder sustainability/recovery</i>	<i>Local improvements made, but higher-level gaps remain</i>  <i>Preparedness focused on storms, not smaller scale emergencies</i>

**Table 2: Impact of Concern’s preparedness work. It shows that each case starts out with a different level of preparedness, from low (L) to medium (M) and high (H), and that Concern’s interventions improve preparedness. The table is based on an interpretation of data collected from field visits.**

While the organisation has improved preparedness in all contexts, there are still gaps. The preparedness systems are mainly geared for large-scale emergencies, namely cyclones and hurricanes, and have limited focus on localised risks like coastal erosion and storm surges, which in aggregate have a large impact on local communities. Tsunami EWS is also undeveloped in all areas, as is EWS for non-coastal hazards like drought. Government structures face severe financial limitations, and many have little ability to support interventions post-Concern, meaning that equipment can break down and not get replaced, or training delivery can be reduced.

In order to reduce response time, **access to remote communities must be considered** – such as through road and bridge improvements or, perhaps **better for coastal areas, the provision of boats**. However, while all areas need them, Concern has only provided boats in Haiti. This is largely related to financial constraints.

Communities cannot be reliant on external agencies to always respond to emergencies, so need the capacity to cope with, respond to, and recover from disasters. **Preparedness planning is required** – of evacuations; stockpiles; making sure essential documents are safe; and identifying who would look after children, the elderly, and the disabled and sick. **The aftermaths of disasters are windows of opportunities to improve preparedness** since stakeholder awareness and willingness for preparedness is high. Planning steps have been done at the community level in Mozambique and Haiti, but at the household level in Bangladesh. One lesson that comes through in all of these planning processes is: **the shorter and more succinct the plans are, the more useful they are.**



Contingency plans are designed to be initiated once a warning from an early warning system has been given. All three countries have an EWS in place for cyclones/hurricanes, and Concern's role tends to be at the interface between the EWS and the community – helping disseminate warnings and ensure preparedness plans are in place. **A number of communication methods should be employed**, including flags, megaphones, and drums and horns, in order to ensure that all vulnerable people are aware of an incoming storm. This communication system could be used for **warnings concerning other hazards that do not currently exist in the countries concerned, such as tsunamis or droughts**.

It is not enough to just provide warnings – **people need to be sensitised** in order to have some belief in the warnings, knowledge of preparedness and contingency plans, and willingness to 'abandon' their houses and assets for storm shelters.

In all the study contexts, **there are not enough storm shelters for everyone**. This means people must use schools and well-constructed houses as shelters. Any buildings used as storm shelters need to be designed to withstand the wind speeds and storm surges; seeking shelter in structures that are not appropriately designed can increase risk. This needs to be addressed by retrofitting or building bespoke buildings that can serve as shelters. If schools, hospitals, or other non-dedicated structures are used as storm shelters, care must be taken to ensure that they are still able to provide services following disaster. Using shelters can also be a security risk. Security measures need to be in place to protect people using shelters, and, if possible, for the assets they leave behind in their houses.

The following general lessons can be learned from the preparedness measures Concern employs in coastal areas:

- Building response capacity, reducing response times, and improving information flows are all parts of coastal preparedness.
- Preparedness needs to focus on all stakeholders involved in responses, from households and communities to governments and NGOs.
- Preparedness should start by assessing the current level and approaches to preparedness, and building upon them.
- Storm shelters need to be strong, with good security, and located in areas that are easily accessible.
- Supplies can be located at household, community, and organisation level and should be stored in such a way that they can be accessed and distributed quickly and efficiently.
- Prepositioning supplies, including supplies like seeds for early livelihood recovery, can help communities to recover quickly from coastal disasters.
- EWS should be comprehensive and include all priority hazards including drought and tsunami, not just cyclones or hurricanes.
- Large disasters can provide a window of opportunity to catalyse the development of a preparedness system.

## Natural resource management

Natural resources can be strengthened to reduce the probability and impact of coastal-based hazards, making natural resource management (NRM) a key component of mitigating disaster risk. Unlike preparedness, which falls solely in the domain of human action, natural resources are by definition non-human so can only be *influenced* by humans, demonstrating the interconnected nature of humans, their environment, and disaster risk.

Concern uses NRM across all of its coastal contexts. Its efforts focus on improving natural resources to offer protection from hazards, to build sustainable livelihoods, and to improve the utilisation of water. Figure 8 illustrates the activities within these categories:

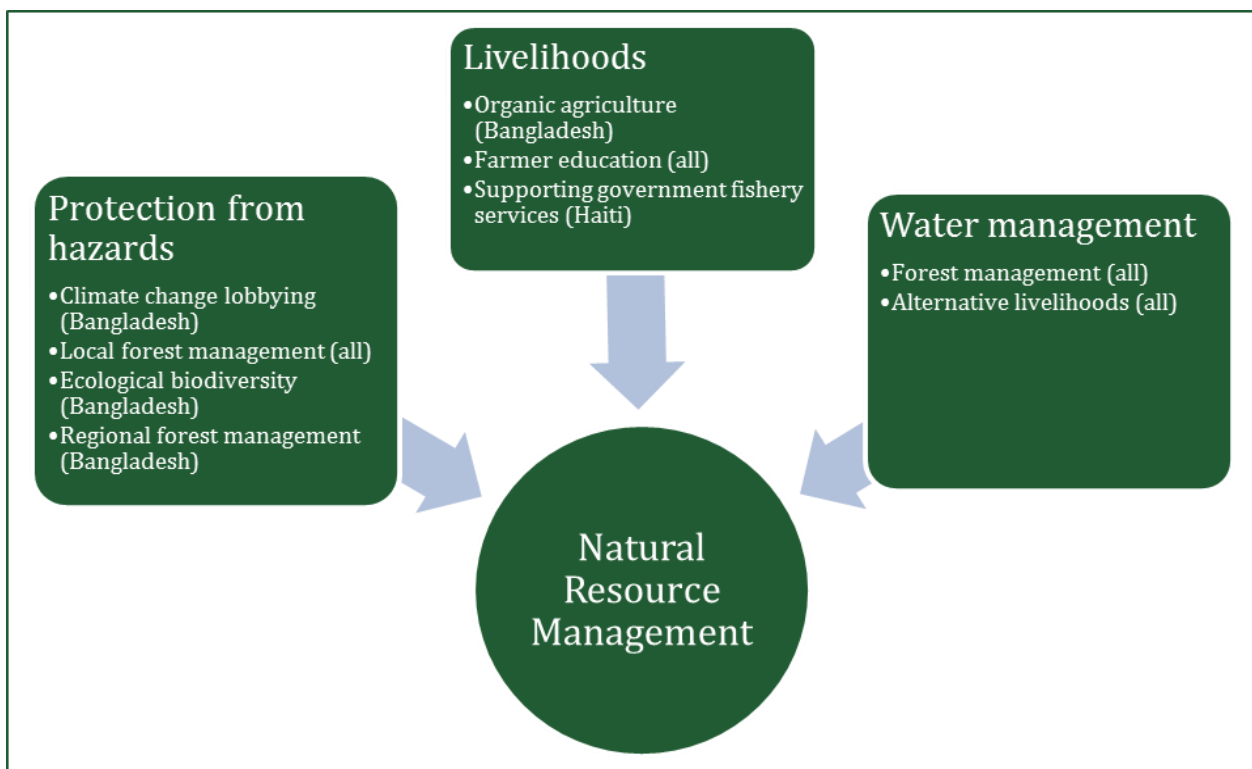


Figure 8: Core components of natural resource management in coastal contexts

## Protection from hazards

Natural resources provide protection from hazards. Haiti, Mozambique, and Bangladesh all have coastal mangrove forest systems, which can buffer storms and erosion. Haiti and Mozambique also have freshwater forests that help reduce landslide and erosion risks and improve water supplies, reducing drought risk. In addition to offering hazard protection, forests also harbour biodiversity and are a source of natural resources themselves.

Human encroachment on forests can increase forest-based risks. Bangladesh has over 5,000 'tiger widows', women whose husbands were killed by tigers while using the forests. Disease outbreaks, including HIV/AIDS and Ebola, have been thought to have emerged from animals living in tropical forests (Pourrut *et al.*, 2005; Weiss and McMichael, 2004).




Climate systems influence natural resources and have DRR implications. Forests help regulate weather patterns, and if forests are disturbed they can increase erratic weather, including extreme variations in level and timing of rainfall. Human induced climate change caused by the release of greenhouse gases into the atmosphere is destabilising the climate and increasing the risk of climate induced disasters.



*The forests of Mozambique (top) Bangladesh (middle) and Haiti (below). Forest degradation is minor in Mozambique, moderate with pockets of high degradation in Bangladesh, and extreme in Haiti, with most of the area deforested or scrubland.*

The level of environmental degradation, including degradation of forests, varies between contexts (see photos above). The forests in Mozambique are relatively intact; those in Bangladesh are intact but becoming increasingly depleted, particularly around the more settled areas; and those in La Gonâve have mainly disappeared, with freshwater forests replaced with scrub, which provides much lower hazard and livelihood support compared to mature forests. As forest resources vary across the contexts in which Concern works, Concern takes different approaches to forest management.



In Mozambique, Concern's forestry management practices are minimal and mainly focus on small-scale targeted afforestation near certain embankments to control erosion. Concern is also using reforestation to control erosion in Bangladesh and is making concerted efforts to conserve the Sunderbans. Conservation includes improving livelihoods to reduce reliance on the Sunderbans as a resource as well as promoting the co-management of forests between government and local population. In Haiti, Concern focuses on freshwater forestry including reforestation.

The erosion control efforts in Bangladesh and Mozambique focus on planting fast-growing trees or grasses with deep roots (often mangroves and bamboo) near coastal areas exposed to erosion. Erosion is especially prevalent in where river and coastal waters intersect and is more likely to occur during storms when waters are fast flowing. In many cases, erosion is the main hazard, even more so than cyclones or hurricanes, so disaster management committees often focus on erosion control interventions based on results of participatory hazard analysis. Concern provides trees for planting in both Bangladesh and Mozambique, selecting varieties that are common to the area and well adapted to the climate and soils. Beneficiaries themselves plant the trees. In Bangladesh they are often paid as part of government cash for work and social protection schemes, but in Mozambique they work voluntarily as part of a community contribution toward DRR efforts. To give trees a chance to take root, they are planted at times in the year when water is flowing slowly and storms are not likely.

In Bangladesh and Mozambique, efforts to control erosion with afforestation received mixed reviews from staff and beneficiaries. In both countries, natural forests were actually providing protection from storms and erosion, however in both cases intentional reforestation failed to prevent erosion in the targeted areas. This suggests a need to plant a higher volume of trees or more developed trees per area.

While reforestation addresses localised hazards related to erosion, in the Sunderbans Concern is working on building up and protecting an entire forest system that spans two countries. The work is multifaceted. A main component focuses on reducing Sunderban resource use by developing alternative non-Sunderban dependent livelihoods. Beneficiaries throughout the region use the Sunderbans mainly out of desperation as a survival mechanism in response to livelihood failures, e.g. the salinisation of agricultural land from Cyclone Aila. While they can make good money harvesting Sunderbans resources - often more than they make by engaging in fishing and agriculture - they state that they prefer other livelihood activities because of the dangers associated with being in the forest, including tiger attacks, robbers who kidnap their victims for a ransom, and government officials who levy fines for illegal use of the forest.

To reduce Sunderbans use, Concern provides small grants for livelihoods, generally ranging between \$25 and \$100, to poor and vulnerable beneficiaries who are dependent on the Sunderbans for their livelihoods. Some use this money on its own to start their own businesses, however most end up supplementing the grant money with their own small savings. Concern also provides beneficiaries with training including general business management skills and specialised training per livelihood activity, usually conducted over the course of two days. Beneficiaries themselves choose the business they wish to start, and they range from small-scale livestock rearing and agriculture to aquaculture and petty trade. Beneficiaries state that through these interventions they are able to decrease their Sunderban use substantially, many going from entering the Sunderbans daily to only going a few days a month.

Concern also tries to reduce demand on Sunderbans resources. It has introduced a type of fuel-efficient stove that uses around a third less fuel than traditional stoves, reducing Sunderbans fuel dependence and saving fuel costs (Alam and Chowdhury, 2010). By burning fuel more efficiently, these stoves produce less smoke. They also have a better ventilation system than traditional stoves. These innovations reduce indoor air pollution, so decreases respiratory diseases for women and children. The stoves also have a faster cooking time, reducing women's labour burden. The earthen stoves can be constructed by hand using local materials, the same technique as traditional stoves, with the only additional monetary expense being a small aluminium flue.

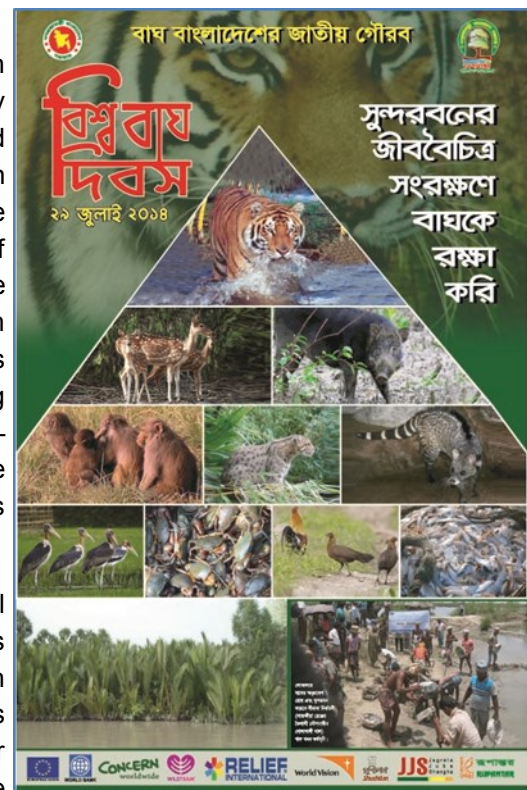


*Concern's earth stoves are approximately a third more efficient than traditional earth stoves.*

Concern has also established a nursery for trees. Beneficiaries buy trees to plant in their homesteads, some of which are used for fuel, creating a non-Sunderbans intra-village supply of fuel. The nursery also sells fruit-bearing trees, which offer a source of food. A local family operates the nursery and makes enough money to support themselves and build savings.

Lastly, Concern focuses on improving relations between communities and the governments over forest resource by establishing co-management committees, legally recognised organisations designed to facilitate engagement in Sunderbans forest management. Forest co-management is the process of sharing power, responsibilities and benefits of natural forests among users (Persoon *et al.*, 2003). The committees are comprised of project participants, all of whom are Sunderbans users and are linked with the organisation's other development groups. The committees focus on engaging with the forestry department to develop, implement, and follow-up co-management plans. This work helps develop a more collaborative form of managing the Sunderbans that is reflective of everyone's needs.

Concern extends its co-management efforts beyond local level work with farmers and forestry officials. The Sunderbans span geographic jurisdictions, occupying parts of both Bangladesh and India, so Concern's work includes engagement with government officials of both countries. Their management also spans departmental boundaries, with some elements the responsibility of departments of forestry, others the responsibility of fisheries, agriculture, or water development. Concern works with all these officials to improve resource management.



*In Bangladesh Concern recognises the importance of the Sunderbans as a biodiversity hotspot. Above is a picture of a poster that Concern helped to produce depicting the Sunderbans ecosystem.*

The Sunderbans also have international significance as a major carbon sink and a biodiversity hotspot, so Concern uses its work as part of broader lobbying to improve climate change relations. As a whole, Bangladesh is disproportionately affected by the effects of climate change compared to its levels of carbon dioxide emissions, so Concern is engaging in regional and international climate change dialogue sessions focused on reducing carbon dioxide emissions and financing climate change adaptation.

## Livelihoods

From a DRR perspective, households with strong livelihoods can invest in their assets to make them more resilient to hazards, and use their assets to recover quickly following disasters. As most coastal beneficiaries use coastal resources in some way for their livelihoods, livelihood activities can either degrade or improve the natural environment, which can change the hazard profile of the area. DRR, NRM, and livelihoods therefore complement each other in coastal areas, and Concern often works at this intersection to reduce risk and address extreme poverty.

In Haiti, Mozambique, and Bangladesh, Concern works to educate farmers on how to structure their livelihoods to promote sustainability. In Mozambique, Concern has set up farmer field schools - farmer groups that come together to learn from each other and improve their livelihoods - which the organisation has linked to the DRM committees. In Bangladesh, Concern's livelihood work focuses on self-help groups, groups of women who come together to support each other in a number of activities. In both cases, Concern organises these groups, targeting the poorest and most vulnerable, and provides them with training with DRR components focused on diversifying livelihood production (which helps ensure livelihoods do not fail as a result of a single hazard); by reducing exposure to hazards; by promoting forms of livelihoods that are more resistant to hazards; and by promoting livelihood activities that do not exacerbate hazards. In Bangladesh, it also offers material support in the form of small grants for starting up small businesses, while in Mozambique it provides field school members with agricultural inputs.



*Inderjit Mandal, a nursery manager, with one of his mangrove saplings. The nursery provides a livelihood and a source of trees for the community.*

In Mozambique, Concern has supplied communities with drought tolerant, fast germination, high yield rice varieties. Faster cultivation can reduce exposure to hazards: traditional rice takes six months to cultivate, whereas the varieties introduced by Concern only take three, reducing the chances of crop failure by decreasing hazard exposure. The seeds were provided to beneficiaries once, but they have been saved and spread following harvests. In Mozambique, through the DMCs, Concern is also promoting the '3 farm' system, whereby households grow their crops on three farms in separate locations. Diversifying locations helps reduce the chance of a single disaster wiping out all crops. One committee member noted that this drastically reduced the livelihood impact of floods and drought and that most community members had adapted this approach to agriculture. This technique is only available because land is not scarce and can be devoted to multi-farming methods.

Self-help groups in Bangladesh are structured around collective savings to establish collective businesses. The groups are comprised of women, who each contribute about one dollar per month toward a business, and it takes anywhere between two and four years to save in full depending on the size of the business. Concern also provides self-help groups with grants and business training. While the training is targeted at improving asset bases it also includes issues related to sustainability such as promoting organic agriculture, including the utilisation of organic pesticides and fertiliser made from animal manure. Compared to conventional approaches organic methods save money and are better for the environment, but fertiliser is only accessible for households with livestock and so is usually only an option for better-off households.

## Water management

Water is a key natural resource, vital for life, health, and livelihoods. Concern works to improve water delivery by building and rebuilding wells, rain catchment structures, and other water points. It also improves water quantity and quality through appropriate management of forest and aquaculture systems.

Water delivery is a challenge across contexts, as for all cases water points are few and far between, meaning locals - often women and children - have to travel long distances to secure water. In Haiti, for example, it is not uncommon to walk three hours or more to retrieve water due to a lack of nearby sources. Water points are often unimproved, meaning that people are exposed to water borne diseases. In Bangladesh groundwater is salinised and often has high concentrations of arsenic, meaning most have to rely on rain and surface water harvesting collected from rooftops or open ponds. In Mozambique only about a third of the rural population has access to improved water sources, and sources are often in disrepair. Maintenance of water points and pumps is also a challenge in Mozambique and Bangladesh. Concern works to improve water delivery in a similar manner across each of these areas by: 1) helping to build and repair water point structures; 2) ensuring that water points are maintained by supporting local water management committees; and, 3) improving water supply and reducing source contamination. The specific risk contexts, however, mean these programme interventions are conducted in different ways.




*Rice in a demonstration plot in Bilinguinho, where Concern Worldwide is running a farmer field school to help families living there improve their farming techniques and diversify the number of crops that they grow for sale and consumption. Photo by Crystal Wells, 2014.*

There are many differences in the types of water points Concern constructs. In Haiti and Mozambique Concern constructs groundwater wells. In both cases groundwater is reached by drilling down and a well is constructed, normally with a deep-well hand-pump. In Mozambique, this is a relatively easy task as the groundwater tends to be located a few metres below the surface – that said, wells can go dry in the dry season, meaning drilling to reach confined and stable aquifers is needed. To reduce the risk of surface water intrusion in the wells, which can lead to water point contamination, Concern seals the wells below ground and extends the well’s protective structure about a metre above ground, higher than peak flood level. In Haiti, the waterline is much deeper so at times Concern has to drill up to 250 meters and punch through a hard limestone layer. Drilling costs are high, which are exacerbated by the need for hydro-geological surveys to determine the best place to drill.



*These pictures show some of the ways Concern improves water. In Mozambique (upper left), Concern rehabilitates and rebuilds water points that are damaged or in disrepair, constructing points on a raised platform to reduce exposure to floods. In Haiti (upper and middle right), Concern goes to great lengths to hazard proof its water points and deliver water to communities in need. These pictures show a water point being repaired. The point is located in a gully, so is being built to withstand floods, in addition to earthquakes and storms. In Bangladesh (middle left and below), Concern’s work focuses on improving surface water as groundwater is salinised and often contaminated with arsenic. In some cases, Concern will help improve ponds (right below), and in others it will help households shift from traditional collection and storage techniques (left below), to improved techniques (left middle).*



Since drilling costs in La Gonâve can often be high, whenever possible Concern develops and improves springs (areas where groundwater naturally flows up to the surface). Concern caps these springs and, when they are located far from settlement areas, pipes the water into villages. Improving these springs can be straightforward but making them resistant to hazards can be a challenge as some are located in landslide and flood prone gullies and the entire area is exposed to earthquakes. Concern has invested considerable resources in making these structures more hazard resistant.

In coastal areas of Bangladesh groundwater is brackish and contaminated with arsenic so people often rely on surface water as their main source of water. Concern improves surface water collection by developing rainwater harvesting ponds and rooftops and storage structures. Unlike in Haiti and Mozambique, where work occurs mainly at community level, this work occurs at both household and community levels, as both can be used to develop water sources with equal efficiency. At the household level, Concern provides material inputs to set up rooftop water harvesting systems. It also provides plastic or concrete water storage tanks for storing the water which, compared to traditional earthen storage pots (see photo below), can store a larger volume of water in a safer manner.

As a storage material, concrete is preferable to plastic as it lasts longer, but it is also more expensive so Concern mainly provides plastic tanks. It also supports rooftop harvesting from community buildings and works to improve rainwater-harvesting ponds. Larger-sized ponds can capture more rainwater than smaller ones, which increases the amount of water available and improves water quality by diluting brackish water. Through cash for work projects Concern deepens and widens water ponds, using the excavated soil to raise paths, roads, meeting places, and other areas to reduce flood risks. These are often implemented as part of disaster recovery and further help stimulate the local economy.

Harvesting surface water has its problems; ponds are open to the elements so can be contaminated and supply is weather-dependent, meaning that beneficiaries can, at times, be left with little drinking water. It may be possible to develop groundwater sources in the area, as it is something Concern has done in Liberia, the Maldives, the Democratic Republic of the Congo, and other similar contexts. However, such projects require high levels of training and management.

Concern works to establish water management committees to help manage water points. They are comprised of local community volunteers who educate other communities on water utilisation, holding sensitisation meetings on the subject, and work to keep water points in order. To do this, committees collect small monthly fees from users, which are used to cover material and equipment for repairs, waiving the fee for the poorest and most vulnerable users. In Haiti, the committees also liaise with NRM committees to protect or improve forests to improve water supply. However, they consider results of this engagement mixed, noting that in many situations land remains unprotected. In Bangladesh, committees manage community level water structures and households manage their own water points. In Haiti, Concern has found certain challenges and opportunities for water management:

<b>Challenges</b>	<b>Opportunities</b>	<b>Resources / Requirements</b>
<b>Drilling/ technical supervision</b>	<ul style="list-style-type: none"> <li>Local staff capacity building</li> </ul>	<ul style="list-style-type: none"> <li>Appropriately skilled hydrogeologists, engineers and drilling team</li> </ul>
<b>Technical data collection and application</b>	<ul style="list-style-type: none"> <li>Database establishment / management</li> <li>Improve understanding of regional hydrogeology/ geology and applications of models</li> </ul>	<ul style="list-style-type: none"> <li>Appropriately skilled hydrogeologists for implementation and management.</li> <li>Willingness of other groundwater actors to engage in data collection</li> </ul>
<b>Remote working locations</b>	<ul style="list-style-type: none"> <li>Local staff capacity building (project management and planning)</li> </ul>	<ul style="list-style-type: none"> <li>Appropriately skilled hydrogeologists, logistics, and drilling team</li> </ul>
<b>Establishment of local water committees</b>	<ul style="list-style-type: none"> <li>Local community sensitisation and water committee development.</li> <li>Long term data collection on performance of water committees</li> </ul>	<ul style="list-style-type: none"> <li>Long term community, NGO, and government commitment</li> <li>Availability of a local spare part network</li> <li>Willingness of beneficiaries to pay for water and to participate</li> </ul>
<b>Long term monitoring</b>	<ul style="list-style-type: none"> <li>Improved understanding of groundwater systems</li> <li>Adaption to climate change and disaster risk reduction.</li> </ul>	<ul style="list-style-type: none"> <li>Application of both “hi tech” and “practical” monitoring techniques</li> <li>Appropriately skilled hydrogeologists</li> <li>Long term technical support provision</li> </ul>

*Table 3: Groundwater challenges and opportunities in La Gonâve (from Evans, 2014)*

Table 3 focuses on organisational approaches to water point development, and includes the importance of developing water management in light of DRR and CCA. It also touches on the importance of engaging with appropriate duty bearers when developing points, including water management committees and government agencies. This is a challenge in Haiti and many other areas since government services are often absent and committees are unable to provide anything more than basic support.

In Haiti and Bangladesh Concern uses NRM to improve water quality. In Haiti Concern focuses on improving supply by planting trees and other flora and by constructing check dams and terraces. This slows down the flow of water and improves absorption into the soil. In Bangladesh, the work focuses on reducing salinisation by developing agricultural models that offer an alternative to shrimp farming, an activity responsible for some of the salinisation of water supplies. It also improves embankments and supports the protection of mangroves to keep salt water out of rainwater ponds, as seawater can penetrate ponds. Some farmers have shifted from shrimp farming to other agricultural activities, but the water supply remains highly saline.





## Conclusion and lessons to be learned

Concern's NRM approach shows that natural resources are a key component of DRR, and that ecosystems provide protection from hazards, can improve water supply, and are used for livelihoods. Furthermore, the benefits of the approach are not just limited to the local beneficiaries themselves but have broader ecological impact, including the protection of climate and preserving biodiversity - activities that reduce risk at global levels.

Unlike preparedness work, which is conducted mainly through the state structures responsible for disaster risk management, **NRM occurs through multiple sectors not directly related to DRR**, including fisheries, forestry, agriculture, land, and water.

As with preparedness work, an institutional body is important for coordinating and developing NRM, but unlike the preparedness activities, NRM does not fall under a single institutional arena but instead involves various government ministries and bodies including the departments of fisheries, forestry, and land use. **Likewise, in coastal areas, such work can be trans-boundary**, meaning that local, regional, national, and, in the case of climate change, international support is needed to further improve ecosystems. While Concern focuses on developing local natural resource management activities, the experiences in Bangladesh show how these **can be capitalised on by establishing and harnessing multi-stakeholder and multi-level platforms** that, in some cases, may even be multi-country platforms.

Concern's coastal DRR work shows that **NRM in coastal areas does not just revolve around planting trees or grasses, but can also contain structural measures** that improve natural resources such as ponds and embankments. As such, it shows that DRR needs to be mainstreamed across intervention areas and institutional bodies using a range of tools.

Concern's work also shows that, contrary to expectation, in some cases **coastal erosion is prioritised over cyclones or hurricanes**. Responding to this community prioritisation, Concern has tried to replant trees in priority areas where rivers meet the sea, and where erosion is highest. This has not been successful in Mozambique or in Bangladesh; **while natural forests do provide protection from coastal erosion, planted areas do not**. The reasons for this are unclear and should be researched, but are likely to be a combination of the replanted areas never having a chance to mature, and perhaps mistakes have been made regarding the species chosen. **Conservation of existing forests, and especially mangroves, might be a better approach** to protecting coastal areas from erosion as well as diminishing the intensity of storm surges. Where large natural coastal forests still remain, conservation should be prioritised.


Many livelihoods related interventions, even if not called DRR, can also reduce risk. The density of population and heavy reliance on natural resources in coastal areas means that **coastal DRR programmes should also include a strong livelihoods component**. Examples of what can be done include introducing hazard tolerant crop varieties, seeking livelihood alternatives to degrading livelihood practises, and establishing self-help and saving groups.

Likewise, **water management is a common feature of DRR programming in coastal areas**, given that coastal water resources can be salinised or distant.

The differences in approaches and impacts of Concern's NRM work in Haiti, Mozambique, and Bangladesh reflect the various hazards, vulnerabilities, and capacities of the areas. The level of environmental degradation varies dramatically between areas, with relatively little degradation in Mozambique, localised degradation of certain resources in Bangladesh but widespread degradation of water resources, and widespread degradation in Haiti across all areas. As a result, much of Concern's work in Mozambique focuses on capitalising and appropriately using existing resources, the work in Bangladesh centres on protecting resources from further degradation, and in Haiti it focuses on recovering and redeveloping already degraded forests. Table 4 shows the impact of Concern's work in NRM:

	Hazard protection	Water management	Livelihoods
Haiti	L → M	L → M	L → M
Mozambique	H → H	M → M	L → M
Bangladesh	M → M	L → M	M → H
Overall	<p><i>Planting and protecting trees and grasses that offer protection from erosion and coastal storms</i></p> <p><i>NRM for hazard protection requires working with multiple user groups</i></p>	<p><i>Community-level water management can improve water delivery</i></p> <p><i>Forestry and agricultural activities influence water quality and quantity</i></p>	<p><i>Agriculture, fisheries, and forestry key livelihood activities</i></p> <p><i>Environmental degradation increases during emergencies</i></p> <p><i>Education and financial support improve sustainable livelihoods</i></p>

**Table 4: impact of Concern's NRM work.** The table shows that each case starts out with a different level of natural resources, and that Concern's interventions improve NRM. The table is based on an interpretation of data collected from field visits.

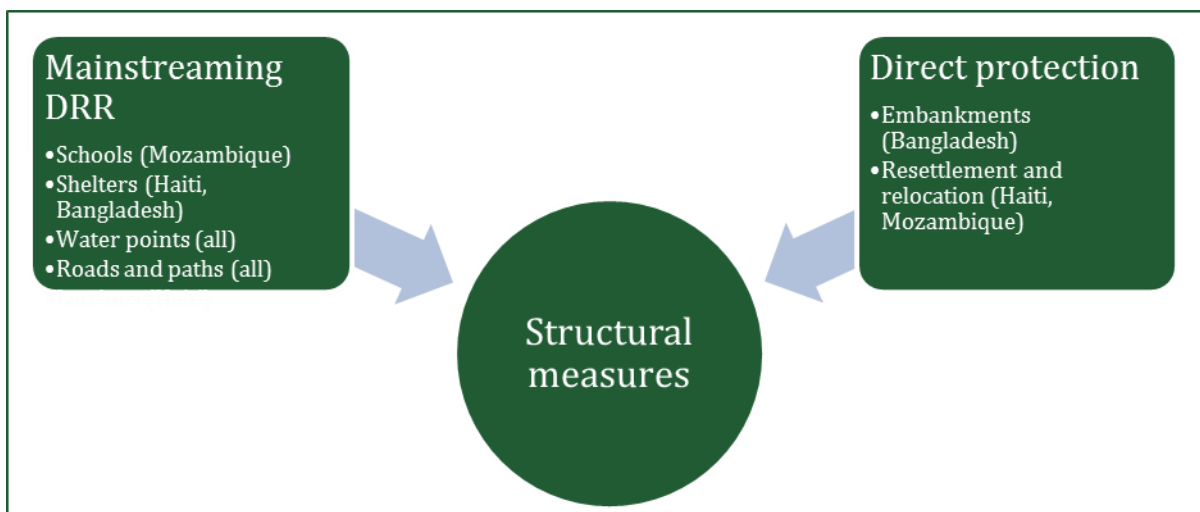


The following lessons can be learned from Concern's NRM in coastal areas:

- Natural resources are key sources of hazard protection, water management, and livelihoods in coastal areas, and so natural resource management should be a key component of any coastal DRR programme.
- Coastal NRM needs to be implemented in conjunction with ecosystem and engineering approaches. NRM cannot be separated from the broader context.
- NRM should focus on curbing destructive practices and conserving remaining natural coastal forests as a matter of urgency.
- In order to apply appropriate regulations on resource use, NRM in coastal areas requires a multi-stakeholder engagement process across multiple levels. Coastal resources are not isolated; some are being degraded by actors operating outside coastal areas and some offer benefits to people living outside these areas.
- Access to natural resources can be a key component of recovery following coastal emergencies. This can, however, increase environmental degradation and risk.
- NRM activities should also include components aimed at improving livelihoods and water resources.
- Given the multi-sectoral nature of DRR in coastal areas it is important to mainstream DRR into all sectors.
- Salinisation can cripple coastal livelihoods, delaying recovery from emergencies and increasing extreme poverty.
- Reducing natural resource degradation can be successful when incentive structures are changed.
- Erosion can be a major hazard. A strong participatory risk assessment can help identify erosion and other potentially overlooked hazards.

## Structural measures

Structural measures, like NRM, are a tool people use to transform and control their environment and make it more conducive for life and livelihoods, including reducing the impact of negative events like disasters. Houses, for example, are often built to provide protection from the weather and to store valuable goods. Other structures are built solely for the purpose of reducing risk: check dams slow water to prevent erosion, and embankments protect against flooding. Concern's structural measures in coastal areas include interventions directly focused on DRR as well as mainstreaming activities, i.e. cases where DRR is not the main goal of the intervention but is rather considered as a secondary outcome of another activity:



**Figure 9: Core components of structural measures in coastal areas**

## Direct protection

Embankments and resettlement or relocation are examples of structural measures implemented to directly reduce disaster risk. Embankments are used as a main structural measure in Bangladesh to reduce coastal flooding and erosion. In Haiti and Mozambique, on the other hand, most of the direct structural measures focus on relocation and resettlement, reducing the exposure of communities to hazards.

An embankment, known also as a levee or a dyke, is a ridge next to a river or coastline that can prevent flooding. Embankments can form naturally as soil is deposited next to riverbanks, but can also be constructed artificially. In Bangladesh, Concern constructs new embankments and raises the height of existing ones. When possible, the organisation builds these embankments to provide protection against high-level flood and storms. However, in certain cases where small-scale storms are common and there are few protective mechanisms in place, it will assist in constructing small embankments to protect against smaller-scale events. In all cases, the embankments also double as roads and paths, so developing them improves transportation and access. The local population also use them as temporary settlement areas when floods and storms inundate their lands, so constructing embankments can help in post disaster-recovery.

Concern often constructs embankments out of earth (this is often as part of the process of deepening water points), and usually plants them with appropriate vegetation (often mangroves or grasses) to reduce erosion. Various government ministries might also improve embankments by lining them with concrete, stones, or other materials, but this can be limited in more isolated areas. Some of these activities are part of Concern's longer-term DRR work, but the organisation also builds embankments as part of its post-disaster rehabilitation and reconstruction, using cash for work to construct the embankments and support livelihoods, taking the opportunity to raise embankments and build back better.

Institutional issues relating to juridical and financial constraints can make building embankments difficult. Local communities have the legal mandate to maintain smaller paths and embankments, but the Roads and Highway Department is responsible for embankments. DMCs are able to mobilise communities to maintain smaller paths, but report difficulties in securing permission and financial resources to improve roads. Furthermore, some of the paths are located in high erosion areas and neither Concern nor the government department responsible for water management - the Water Development Board - has the financial capacity to implement the larger scale mitigation measures described as necessary to prevent erosion.



*Residents of Bangladesh use a number of different types of embankments, including large and strong embankments (left) and smaller ones (centre and right). The larger embankments provide a greater level of protection but at a higher cost. The smaller ones offer protection from small scale hazards that occur frequently - the one pictured prevents agricultural land and settlements from becoming inundated monthly during high tide when the moon is full (spring tides) - but only offer marginal protection from larger hazards. Trees were not planted following the construction of this embankment, but mangroves are beginning to take root, their seeds being naturally swept to the embankment by the moving current.*

In Haiti and Mozambique, rather than building embankments as protection from coastal hazards, Concern tries to relocate communities from higher to lower risk areas, including offering support for reconstruction in those lower risk areas. In Haiti, as part of its Hurricane Sandy recovery efforts, Concern is constructing semi-permanent shelters in areas that are at least two metres above sea level, an area that engineers identify as lower risk to coastal hazards including storm surges and hurricane induced flooding. In cases where elevation changes rapidly, it is easy to locate structures close to water. However, where elevation changes are gradual, structures have to be built far from the coastline, some as far as two kilometres away. Although staff stated that this is necessary to ensure that the structures' concrete foundations are not inundated and destroyed by salt-water, beneficiaries complain that the location makes accessing fisheries and water based transportation difficult.

While in Haiti Concern's relocation work is part of its shorter-term recovery, in Mozambique Concern incorporates relocation into its longer-term DRR. Rather than immediately building new structures in low risk areas, Concern uses DRM committees to conduct bimonthly advocacy discussions designed to convince communities living in high risk areas to relocate to lower risk ones. Concern supports relocation by providing communities with building material and helping to construct key service centres like schools and water points. Instead of identifying high risk areas based on their geographic proximity to the coast, high hazard areas are identified by DMCs using participatory mapping techniques. Committee members have found targeting community leaders to be an effective mechanism for encouraging relocation: they state that once a community leader relocates, the rest of the community generally follows within a few months. With this approach, Concern has been able to convince a large percentage of the population to relocate. Relocation can be contentious – communities often oppose it and it can often increase risk in other areas (Arnall, 2014; Arnall *et al.*, 2013) – but it is government policy, and Concern has been able to gain community acceptance using the right support mechanisms.

These three examples show the various parameters constraining direct protection in coastal contexts. In Bangladesh, Concern's work is limited to building embankments because of the country's high population density and absolute land scarcity makes relocation impossible. In Haiti, the organisation's work is constrained temporally, occurring under a short time period as part of its rehabilitation work, meaning that Concern is able to convince beneficiaries to relocate only by offering higher-quality structures, leaving them torn between lower quality structures closer to livelihoods and higher-quality ones further away. Lastly, in Mozambique, Concern is able to engage with communities over a longer period of time and, as a result, is able to convince many to voluntarily relocate.

## Mainstreaming

Concern constructs a number of structures - including schools, houses, latrines, seed storage silos, roads and paths, and water points, of which the latter three have been discussed previously - as part of its broad approach to reducing extreme poverty in coastal areas. Concern also works to build these structures to resist coastal hazards. In Mozambique Concern constructs schools to be strong enough to double as rudimentary cyclone shelters as part of its cyclone recovery work. Concern follows a UN-Habitat design, strengthening the school walls with additional cross bracing to protect against storms. The schools are basic - some DMCs have requested dedicated concrete storm shelters - but they do provide some storm protection.

In Bangladesh, Concern helps construct houses that can withstand coastal hazards to the point that they can, when necessary, double as basic storm shelters. Shelters are built with six reinforced concrete column pillars and a corrugated iron roof anchored to the ground by an iron rope to protect against storms, and raised on a compacted soil plinth, which is often lined with concrete or stone. The plinth is built up to a metre higher than surrounding standing rainwater during rainy season to offer protection from floods during rains. Concern often includes a household rooftop rainwater catchment system as part of its work, complete with a tank to store rainwater. In some cases Concern provides construction materials and supervises construction, while in others it uses DMCs and other groups to advocate for their construction.

In Bangladesh, Concern helps construct houses that can withstand coastal hazards to the point that they can, when necessary, double as basic storm shelters. Shelters are built with six reinforced concrete column pillars and a corrugated iron roof anchored to the ground by an iron rope to protect against storms, and raised on a compacted soil plinth, which is often lined with concrete or stone. The plinth is built up to a metre higher than surrounding standing rainwater during rainy season to offer protection from floods during rains. Concern often includes a household rooftop rainwater catchment system as part of its work, complete with a tank to store rainwater. In some cases Concern provides construction materials and supervises construction, while in others it uses DMCs and other groups to advocate for their construction.

*These pictures show the exterior (left) and interior (right) of a school in Mozambique constructed with Concern's support, using a UN-Habitat design. The schools are made with local materials with cross braces to add strength against cyclones. DMCs provide labour and material, which allows Concern to provide a concrete floor for the same cost.*



The houses that Concern builds in Haiti, like those in Bangladesh, are designed to provide some protection from storms so also include reinforced beams and a sloped roof to shed rain. Some are designed as temporary dwellings, built to last between two to four years, but families state that they will use them as permanent homes. These houses are basic: they contain one room (some families have subdivided this space into multiple rooms) and a bathroom. Nonetheless, they are sturdier and more secure, cooler, and about the same size as the temporary tents that are often provided following disasters. At \$2,000, they are also slightly more expensive than tents but are designed to withstand run-off, heavy rain, strong winds, fires, and earthquakes. Settlements are being provided with solar lighting to improve security. Beneficiaries provide labour and sand (which has to be brought from the mainland, as sand on the island is poor for construction), and Concern provides technical support, visiting houses regularly while they are being constructed to monitor construction, and financial support for materials.



*One of the houses built with Concern's support in Bangladesh. The house is modeled on a traditional design but built to withstand a higher level of hazards.*



*These pictures show a few different house styles used around La Gonâve. On the upper left is an example of a poorly constructed traditional house found on the island. The house offers little protection from the elements and would not last through a small storm. On the upper right is a temporary house built by Concern. It costs more than a tent (below right, photo credit the Lions Club) but is much more robust and maintains a better temperature. The house on the lower left is a permanent house built by Concern. Before Concern's involvement these houses were being built using salt water to mix concrete, increasing rates of rust of the reinforcement bars and reducing their lifespan.*

Concern also supports another NGO in constructing permanent houses. Before Concern's involvement the NGO was making concrete using saline water. The salty concrete will corrode the metal reinforcement bars and weaken the concrete, so these houses are only estimated to last 10-12 years. Concern has been transporting fresh water to address this.

In La Gonâve, Concern constructs 'ecosan' style composting toilets at household level as part of its earthquake response work. Open defecation is the norm on the island, partly the result of a lack of facilities, partly because of a lack of sanitation knowledge. Ecosan toilets are an alternative to pit latrines, a commonly used toilet style consisting of a pit dug into the ground. While pit toilets are effective for most contexts, they are not suitable for the areas of La Gonâve close to the coastline because the highest groundwater level reaches above ground during the rainy season, meaning that a pit latrine would contaminate the water and lead to water borne diseases. Concern designs these these toilets resist floods and storms, but they did not match the local social context and, as a result, were being used for storage, not defecation, despite the fact that Concern consulted the community and provided them with training before installing the toilets. Beneficiaries state that they did not like the toilets because of the smell. Concern is correcting this problem with another sanitation campaign.



*Concern's ecosan toilets in La Gonâve. The toilets are built to withstand earthquakes, storm surges, and hurricanes and prevent water contamination, but community sensitisation was not conducted for a long enough period for communities to begin using the toilets. Concern will correct this with another campaign.*

## Conclusion and lessons to be learned

Structural measures are important for reducing risk in coastal areas. There are a number of commonalities to Concern's structural work in coastal contexts. In all areas, pockets of higher risk are located closer to coastal waters, as are coastal resources, making DRR and structural measures key components for coastal sustainability.

Concern's work in reducing risk through structural measures depends on the broader local capacities available - in La Gonâve and Mozambique, **where land is plentiful, it may be more effective to try to reduce exposure by moving beneficiaries**, whereas in Bangladesh, **where land is not available, the only option is to improve coastal structures**. While land is plentiful in Haiti and Mozambique, **moving beneficiaries from areas of high to low hazard exposure involves a trade-off between livelihoods and risk reduction that is often contentious**, with Concern, government, and communities taking different perspectives on the matter. Concern must recognise this challenge and work to reduce it as much as possible.



**Concern needs to make a clear decision over who should have the final say in these matters** – if the government and community are at odds with each other, who should Concern support, and if it is the community, how can Concern approach an advocacy strategy without alienating the government?

In all cases Concern can often access resources for **building better, hazard tolerant structures following emergencies as part of post-disaster rehabilitation and recovery**, making that a good time period for building back better. Building back better costs more than simply building back, but structures must be designed to cope with the hazards in the area, a lesson that many, including donors, need to learn. Concern’s work retrofitting schools in Mozambique and rebuilding houses in Haiti has shown that this is both possible and cost effective.


**Engineered structures should be multi-functional wherever possible**: embankments double as roads, paths or dams for rainwater harvesting; earth removed from ponds become dams, plinths or embankments; schools should also be storm shelters. **The pursuit of multi-functionality means working with multiple jurisdictions** – in Bangladesh, for example, the community, the Department of Roads, and Concern, must all be involved for an intervention focused on road improvement.

Concern also has to contend with certain resource limitations. In all cases, it has to make sure it uses appropriate resources, for example by not using saline water in constructing structures and by building structures to withstand peak hazard, a particularly difficult task in areas where resources are limited and beneficiaries are exposed to high magnitude storms. **If a decision on how to prioritise limited resources must be made, it is good to focus on building structures to a high quality and sacrificing quantity**, rather than the other way around. This decision can save lives and money. On the other hand, in the case of disease full coverage is often needed to prevent disease spread. In this case both quality and coverage must be considered.

Behaviour change is always a component of structural measures to help support maintenance and encourage people to use structures that are built. The ecosan toilets in La Gonâve are an example of the failure to adequately address the software components, leading to the toilets being unused. Table 5 shows the impact of Concern’s structural work:

	Direct protection	Mainstreaming
Haiti	L → H	L → M
Mozambique	L → H	M → H
Bangladesh	L → M	L → H
Overall	<i>Reducing exposure to hazards</i>	<i>Using environmentally sustainable locally sourced materials and local labour</i> <i>Developing committees to manage structures</i> <i>Working to reduce saline effects</i>

**Table 5: impact of Concern’s structural measures, based on interpretation of data collected from field visits.**



Overall, a number of general lessons can be learned from analysing Concern's work:

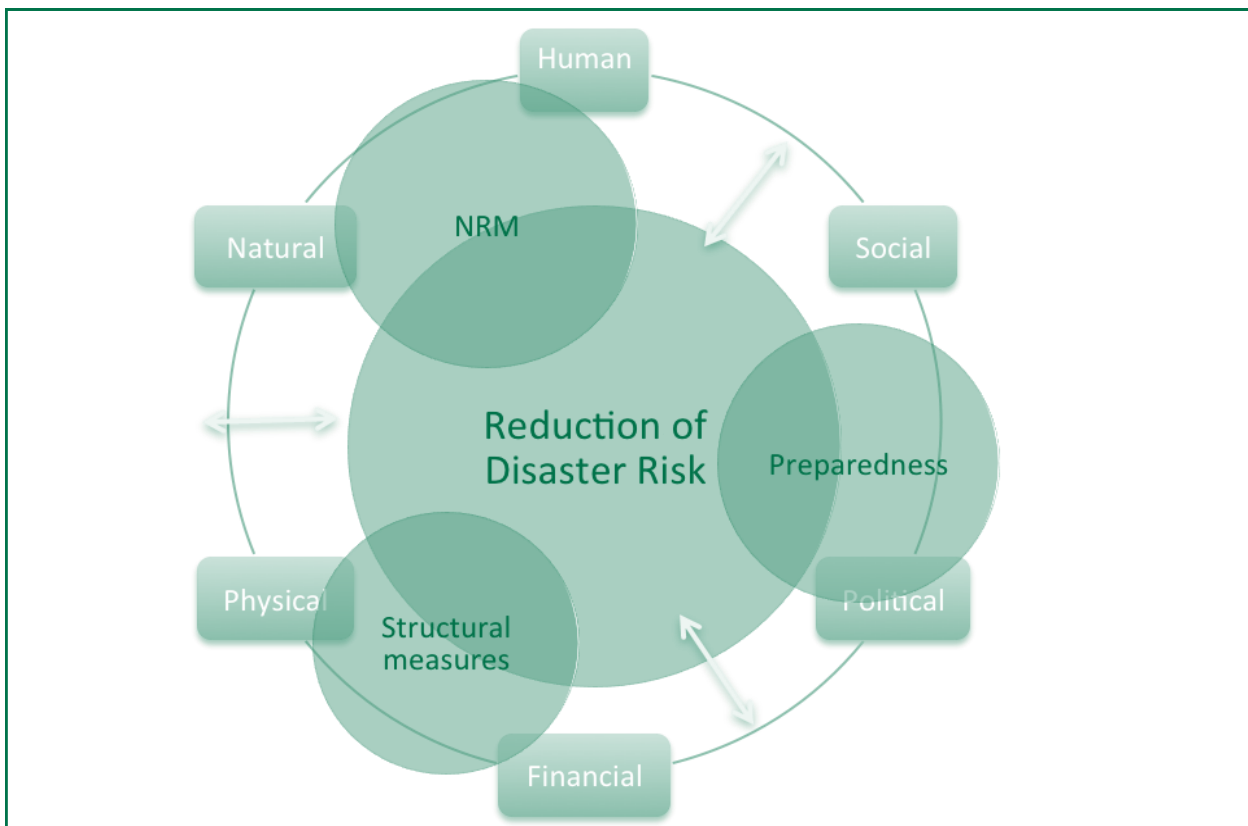
- Major coastal disasters can offer an opportunity for building back better.
- Structural measures should be built with the highest intensity of hazard in mind – which includes considering how hazards are changing in relation to climate change and environmental degradation.
- It is usually better to rebuild a few structures well than many structures badly.
- Relocation is contentious and highly risky, and should be treated with extreme caution.
- The construction process is as important as having an appropriate design, meaning that construction requires support of qualified professionals at all times.
- Behavioural change is required to ensure the maximum benefit is derived from structural measures, and this must be factored into the programme design and implementation. It should focus on use and maintenance of structures.
- Raising structures can help reduce exposure to floods following storms.
- Construction materials need to be selected carefully: using saline water or the wrong type of sand can damage construction and outcomes of interventions.

## Discussion

It is clear that planning and preparedness, natural resource management, and structural measures each contribute to reducing disaster risk in coastal areas. It is also clear that each of the interventions cannot be implemented on its own but, rather, need to be developed in relation to other programming objectives: NRM often complements structural work - Concern plants trees on the sides of the embankments - and its preparedness work in strengthening community DMCs ends up building capacity for them to implement other DRR interventions. As such, these interventions should not be understood separately, but must be viewed in terms of how they can be used in conjunction with each other and broader DRR processes. DRR components need to be integrated with each other for DRR in coastal areas.

The figure below shows that, in coastal regions, preparedness, natural resource management, and structural measures are the three main overarching yet related categories for reducing disaster risk within which all of the above-mentioned interventions can be placed, and that the interventions utilise, protect, and build upon existing assets.

These three areas, when combined, reveal the dynamic and holistic nature of risk and its reduction. From a temporal perspective, structural measures and NRM both focus on stopping disasters from occurring, and preparedness focuses on working to make the impact less severe when disasters do occur. Furthermore, the three activities represent a mixture of scientific and local knowledge, and hard and soft approaches to risk management, and fall between the engineering and ecosystem approaches. All, however, stem from a community-centred approach to risk and risk reduction so operate within the vulnerability paradigm.



**Figure 10: the interplay of interventions, assets, and DRR in coastal areas**

Understanding how all these interventions relate can be a challenge, but, in Bangladesh, Concern has developed four climate smart community based adaptation models that encapsulate this thinking. These household level models are designed to reduce risk to a variety of hazards and improve livelihoods. These pilots combine many of the NRM and structural mitigation techniques discussed above into a comprehensive package that addresses a number of different risks.

One model combines stoves, a legume plantation, and vegetable garden:

### FUEL EFFICIENT STOVE-LEGUME PLANTATION FOR FUEL- VEGETABLE GARDEN

*This model improves food security, nutrition, and health, and reduces Sunderban fuel consumption. It has three components: an energy-efficient earthen stove; wood plantation; and vegetable garden. The stove reduces carbon emissions and household smoke and uses less firewood, the plantation provides a source of fuel, and the garden a source of income and food.*



Another model focuses on rice, fish, and vegetable cultivation:

The third model uses a nursery to improve community and household protection through afforestation:

*This model improves food security, the environment, and reduces risk. It involves converting shrimp farming to a mixed agri- and aqua- culture, and includes raising and strengthening embankments to reduce flooding and salinisation. In highly saline areas it provides added nutritional resilience as farmers can rely on their vegetables year round. Some vegetables are planted in plastic boxes with non-saline soil so that they are not exposed to saltwater.*

#### RICE, FISH, AND VEGETABLE CULTIVATION



#### COMMUNITY AND HOUSEHOLD PROTECTION AND MANGROVE NURSERY



*This model establishes a nursery to reduce Sunderban forest use and increase protective trees. Concern uses the trees grown in the nursery to shore up embankments, and residents can buy trees for their households. The nursery, furthermore, is a business that provides a resident with a steady income.*

The fourth model combines small-scale organic gardening with household structural improvements to build food security and reduce the threat of cyclones and floods:

#### **RESILIENT SHELTER, RAIN WATER HARVESTING, WITH VEGETABLE GARDEN**

*This model improves food security, water supply, and reduces flooding and cyclone risk. It has three components: rainwater harvesting; resilient housing; and salt tolerant vegetable cultivation on a poly-bed. Food, water, and housing are three of the most basic household necessities, all of which this model supports.*



To ensure beneficiaries are well prepared for disasters, all of the members participating in the models have developed household level preparedness plans.

Overall, the models show how households can live sustainably and adapt to the effects of the environmental and climate change. They are mainly designed to be implemented at household level, but also have further community and national significance. At community level, the beneficiaries involved in the project act as community ambassadors, sharing the activities and explaining how they work to their neighbours, families, and friends. Many of these activities have spread: the vegetable gardens can be seen in other locations, for example. Concern is also working to spread the models nationally and internationally; it has brought numerous people to see the models (upwards from 50-60 per model), with beneficiaries again taking on the role of ambassadors to explain how the models work, and has promoted it in government policy and strategy discussions as a solution to living in the coastal areas. As a last step it is in the process of monitoring, documenting, and disseminating the models.



## 4. Conclusion: overall lessons to be learned and good practices for DRR in coastal areas

Wherever the context, Concern works to reduce risk as part of its approach to eliminating extreme poverty. This review is a first step in developing general lessons learned about Concern's approach to DRR in coastal areas. Comparing the organisation's work in three different contexts, La Gonâve, Haiti; the Sunderbans of Bangladesh; and the Chinde district of Mozambique, reveals the similarities and differences in both disaster risks and Concern's approach to DRR. This in turn allowed for generalisations to be made as to what might constitute DRR in coastal regions.

Understanding coastal areas by their risk characteristics is a key first step in developing DRR interventions for coastal contexts. As locations where the ocean meets the land, coastal areas are exposed to common hazards including cyclones/hurricanes, storm surges, coastal erosion, and tsunami, but also face commonalities in terms of livelihood activities, methods of transportation, and means of recovery from disaster. Concern's use of DRR in coastal areas shows how combining preparedness, NRM, and structural measures can be an effective way of reducing these risks and building resilience.

Concern's specific interventions can be assessed as a whole to gain an overall understanding of how coastal DRR should be performed. Concern's activities show that an approach that builds on local social and political capitals can significantly reduce coastal risk. Communities themselves have the ability to reduce coastal risk; top-down interventions might not always work and can, in some instances, create new risks. Scientific knowledge and technical expertise support the organisation's work and play a large role in risk reduction in coastal areas. In all cases, Concern relies on a mixture ecological and structural measures to reduce risk, working towards ecosystem approaches where possible. However, as the heavy reliance on embankments in Bangladesh reveals, engineering approaches are often necessary in cases where land, forests, and other ecosystem services are highly limited.

The three case studies show the importance of integration in coastal DRR: integration of preparedness, NRM, and structural measures; integration of conservation, livelihoods and water resource development; and integration of household and community level work with work at national and international levels.

Coasts are multi-stakeholder areas. Needing an integrated approach implies the importance of operating in multiple jurisdictions and on a variety of levels and scales, and the ability to establish, strengthen and harness the value of multi-stakeholder platforms cannot be underestimated for coastal DRR.

While this report offers a series of lessons on general good practice in coastal areas, such lessons should not be taken as panacea, but must be assessed based on the specific contexts. Coastal areas are not just 'coastal'. They also have other characteristics that shape their risk profiles: from a geographic perspective the coastal areas of La Gonâve are also mountainous, exposed to mountain risks, and those in Bangladesh and Mozambique are also exposed to river based risks. Likewise, the coastal nature of the areas differs. The probability of tsunami, for example, is much higher in Haiti than in Mozambique, and the ability of the government to implement DRR is much greater in Bangladesh than in Haiti.



The following lessons can be learned for DRR in coastal regions:

- A risk based definition of coastal areas can be useful for understanding coastal risk reduction.
- While having commonalities, coastal areas also have certain differences.
- When possible, work to develop interventions from an ecosystem and vulnerability based perspective. Social behaviour change must accompany all infrastructure interventions.
- Structural measures, NRM, and preparedness are all useful for reducing coastal risk and should be used in conjunction with each other. DRR can both protect lives and livelihoods and contribute to asset accumulation and poverty reduction.
- The implications of risk creation and reduction should be assessed beyond the immediate local context. They should be viewed at meso and macro levels (vertically) and across other areas (horizontal). The importance of engaging with multiple stakeholders is paramount.
- Coastal areas are dynamic and constantly changing. Coastal DRR should adapt accordingly.
- Preparedness can save lives and resources.
- DRR is important for all interventions and risk should not just be reduced by stand-alone activities.
- Climate change and its effect on hazard intensity needs to be considered in the design of programmes and structural measures.

Common hazards in coastal areas – cyclones/hurricanes, storm surges and tsunamis – can be extreme. No one intervention – be it preparedness, NRM or structural measures – is enough to counter the forces that can be unleashed in these events. Some interventions – such as larger scale infrastructure projects or even just constructing hazard-resistant housing – can be expensive. Cost is a major challenge in poor countries. NRM can be an inexpensive way of reducing risks associated with small to medium hazards while increasing sustainable access to and return of assets, but structural measures are needed to protect against extreme hazards that can affect coastal areas. Governments, donors and NGOs all need to recognise these challenges and be prepared to implement integrated solutions to address disaster risk in coastal areas.

This report shows that although coastal areas have certain challenges, risk and its reduction is not unique to coastal areas. In all cases inequality, lack of services, extreme poverty, and environmental degradation contribute to risk, showing that risk is ultimately a human expression of deep-seated social patterns, not a natural product. Likewise, the report also shows that risk reduction requires changing those social patterns and relations at local, national, and international levels and across all sectors, through a multitude of interventions and actors. These issues all involve classic DRR principles including analysis, preparedness, mitigation, and advocacy, meaning that the well-established general tools for reducing risk can be adapted and applied to coastal regions.

## Notes

1. Concern defines DRR as “the process of protecting lives, livelihoods and assets of communities and individuals from the impact of hazards (Concern 2005)”.
2. Comprising the analysis of hazards, vulnerabilities and capacities, which leads to action planning period.
3. Including those aimed at strengthening livelihoods, reducing inequalities, and building human, social, political, natural, financial, and physical capitals.

## References

- Abreau, C. 2013. National progress report on the implementation of the Hyogo Framework for Action (2011-2013). National Institute for Disaster Management (INGC).
- Acheson, James M. *The Lobster Gangs of Maine*: Upne, 1988.
- Albala-Bertrand, Jose-Miguel. "Complex Emergencies Versus Natural Disasters: An Analytical Comparison of Causes and Effects." *Oxford Development Studies* 28, no. 2 (2000): 187-204.
- Alam, SM Nazmul and Sakila Jahan Chowdhury. "Improved Earthen Stoves in Coastal Areas in Bangladesh: Economic, Ecological and Socio-Cultural Evaluation." *biomass and bioenergy* 34, no. 12 (2010): 1954-1960.
- Arnall, Alex. "A Climate of Control: Flooding, Displacement and Planned Resettlement in the Lower Zambezi River Valley, Mozambique." *The Geographical Journal* 180, no. 2 (2014): 141-150.
- Arnall, Alex, David SG Thomas, Chasca Twyman and Diana Liverman. "Flooding, Resettlement, and Change in Livelihoods: Evidence from Rural Mozambique." *Disasters* 37, no. 3 (2013): 468-488.
- Baptiste, Marie Alta Jean. *Rapport National De Suivi Sur La Mise En Œuvre Du Cadre D'action De Hyogo (2011-2013): Haiti*. Ministère de l'Interieur, des Collectivités Territoriales et de la Sécurité Nationale, 2013.
- Brander, Luke M, Alfred J Wagtendonk, Salman S Hussain, Alistair McVittie, Peter H Verburg, Rudolf S de Groot and Sander van der Ploeg. "Ecosystem Service Values for Mangroves in Southeast Asia: A Meta-Analysis and Value Transfer Application." *Ecosystem Services* 1, no. 1 (2012): 62-69.
- Burton, Ian, Robert W. Kates, Gilbert F. White. *The Environment as Hazard*: Oxford University Press, 1978.
- Cannon, T. "Vulnerability Analysis and the Explanation of "Natural" Disasters." In *Disasters, Development and the Environment*, edited by A. Varley. Chichester: John Wiley, 1994.
- Chua, Thia-Eng, Danilo Bonga, Nancy Bermas-Atrigenio and Daisy Padayao. *The Dynamics of Integrated Coastal Management: Practical Applications in the Sustainable Coastal Development in East Asia*: Pemsea, 2006.
- Church, John A, Peter U Clark, Anny Cazenave, Jonathan M Gregory, S Jevrejeva, A Levermann, MA Merrifield, GA Milne, RS Nerem and PD Nunn. "Sea Level Change." *Climate change*, (2013): 1137-1216.





- Clark, John R, SM Garcia and JF Caddy. *Integrated Management of Coastal Zones: Food and Agriculture Organization of the United Nations Rome*, 1992.
- CNN. "2011 Japan Earthquake-Tsunami Fast Facts." *CNN* 2015.
- Concern. (2005). *Approaches to Disaster Risk Reduction: Concern Worldwide*.
- Concern. (2010). *How Concern understands extreme poverty (HCUEP): Concern Worldwide*.
- Concern. (2012). *Risk Analysis Guidelines: Concern Worldwide*.
- Concern. (2012). *Report of the Contextual analysis in Zambesia and Manica Provinces, Mozambique. Concern Worldwide*.
- Cooper, J., & McKenna, J. (2008). Working with natural processes: the challenge for coastal protection strategies. *The Geographical Journal*, 174(4), 315-331.
- CRED. *EM-DAT: The OFDA/CRED International Disaster Database-Bangladesh*. Centre for research on the epidemiology of disasters (CRED), 2015.
- Evans, Paul. *Groundwater Supply Development, West La Gonave, Haiti: Challenges and Opportunities*. Concern Worldwide, 2014.
- Gupta, Anil K and Sreeja S Nair. "Ecosystem Approach to Disaster Risk Reduction." *National Institute of Disaster Management, New Delhi*, (2012).
- Hewitt, Kenneth. *Interpretations of Calamity from the Viewpoint of Human Ecology*: Taylor & Francis, 1983.
- Hewitt, Kenneth. *Regions of Risk: A Geographical Introduction to Disasters*. Edinburgh Gate: Addison Wesley Longman Limited, 1997.
- McGranahan, Gordon, Deborah Balk and Bridget Anderson. "The Rising Tide: Assessing the Risks of Climate Change and Human Settlements in Low Elevation Coastal Zones." *Environment and Urbanization* 19, no. 1 (2007): 17-37.
- Moser, S. C., Jeffress Williams, S., & Boesch, D. F. (2012). Wicked challenges at land's end: managing coastal vulnerability under climate change. *Annual Review of Environment and Resources*, 37, 51-78.
- Nicholls, Robert J and Anny Cazenave. "Sea-Level Rise and Its Impact on Coastal Zones." *science* 328, no. 5985 (2010): 1517-1520.
- NOAA. "Tropical Cyclone Tracks." 2010.
- Pourrut, X., Kumulungui, B., Wittmann, T., Moussavou, G., Delicat, A., Yaba, P., Nkoghe, D., Gonzalez, J.-P. & Leroy, E. M. 2005. The natural history of Ebola virus in Africa. *Microbes and infection*, 7, 1005-1014.
- Rahman, Mohammed M, M Motiur Rahman and Kazi S Islam. "The Causes of Deterioration of Sundarban Mangrove Forest Ecosystem of Bangladesh: Conservation and Sustainable Management Issues." *AAFL Bioflux* 3, no. 2 (2010): 77-90.



UNESCO. *Coastal Zone as an Ecological, Social and Economic System*. UNSECO, n.d.

UNISDR. "Sketch of Global Tsunami Hazard." UNISDR, 2009.

UNISDR. (2009). *UNISDR Terminology on Disaster Risk Reduction*.

Van Heerden, Ivor LI. "The Failure of the New Orleans Levee System Following Hurricane Katrina and the Pathway Forward." *Public Administration Review* 67, no. s1 (2007): 24-35.

Weiss, R. A. & McMichael, A. J. 2004. Social and environmental risk factors in the emergence of infectious diseases. *Nature medicine*, 10, S70-S76.

World Bank. *Natural Resource Management*. World Bank, 2000.

Zakir, Ahsan. *National Progress Report on the Implementation of the Hyogo Framework for Action (2009-2011)*. Disaster Management Bureau, Disaster Management and Relief Division, Ministry of Food and Disaster Management, 2011.



# CONCERN

worldwide

[www.concern.net](http://www.concern.net)

## Republic of Ireland

52-55 Lower Camden Street, Dublin 2

**T** 00 353 1 417 77 00 **E** [info@concern.net](mailto:info@concern.net)

## Northern Ireland

47 Frederick Street Belfast, BT1 2LW

**T** 00 44 28 9033 1100 **E** [belfastinfo@concern.net](mailto:belfastinfo@concern.net)

## England and Wales

13/14 Calico House Clove Hitch Quay London, SW11 3TN

**T** 00 44 207 801 1850 **E** [londoninfo@concern.net](mailto:londoninfo@concern.net)

## Republic of Korea

Chunji Building, 2F, 374 1 Seogyo-dong, Mapo-Gu Seoul, 121 894

**T** 00 82 324 3900 **W** [www.concern.kr](http://www.concern.kr)

## USA

355 Lexington Avenue 16th Floor New York, NY 10017

**T** 00 1 212 5578 000 **E** [info.usa@concern.net](mailto:info.usa@concern.net)

Published by Concern Worldwide

© Concern Worldwide 2015

Concern Worldwide encourages printing or copying information exclusively for personal and non-commercial use provided that the source is clearly acknowledged.

Concern Worldwide

Working with the world's poorest people to transform their lives

[www.concern.net](http://www.concern.net)

**CONCERN**  
worldwide