Concern Disaster Risk Reduction - Mountain Contexts

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Acknowledgements

This publication draws on ten years of experience from Concern Worldwide's disaster risk reduction programming experience in mountain contexts. 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.

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Terracing in the central highlands, Amhara Region, Ethiopia, 2013. Photo by Aaron Clark-Ginsberg, 2013

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Acronyms and Abbreviations

ANDMA	Afghanistan National Disaster Management Authority
AWD	Acute Watery Diarrhoea
CAG	Contextual Analysis Guidelines
CBO	Community Based Organisation
CDC	Community Development Committees
CFW	Cash for Work
CMAM	Community Management of Acute Malnutrition
DFID	Department for International Development
DMC	Disaster Management Committees
DRR	Disaster Risk Reduction
EWS	Early Warning Systems
FEWS NET	Famine Early Warning System Network
HCUEP	How Concern Understands Extreme Poverty
HKH	Hindu Kush Himalayas
HDI	Human Development Index
HFA	Hyogo Framework for Action
NGO	Non-Governmental Organisation
NRM	Natural Resource Management
OCHA	United Nations Office for the Coordination of Humanitarian Affairs
PIPs	Policies, Institutions, and Processes
PEER	Preparedness in Emergency Response
PSNP	Productive Safety Net Programme
RAG	Risk Analysis Guidelines
SAM	Severe Acute Malnutrition
SOP	Standard Operating Procedure
UNEP	United Nations Environmental Programme
UNISDR	United Nations International Strategy for Disaster Reduction
WASH	Water, Sanitation, and Hygiene

Executive Summary

This report describes Concern Worldwide's approach to disaster risk reduction (DRR) in mountainous contexts. Mountains were chosen to showcase Concern's approaches to addressing hazards typically found in these areas: quick onset and flash flooding; landslides; water erosion; and, in some cases, earthquakes and volcanic eruptions.

Concern Worldwide is an international, non-governmental, 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.

Concern works closely with and for the 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 approaches 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.

Some 22 percent of the world's population live in areas that can be classified as mountainous. Mountains are rich sources of biodiversity and culture. They are particularly important in providing access to fresh water resources with some 3 billion people relying on fresh water from mountainous regions. Yet mountains are often geographically and politically marginalised areas representing areas with high incidence of poverty and intense hazards. Consequently, risk reduction is essential for the development of these regions.

This paper documents and compares Concern's DRR programming experience from the northern highlands of the South Wollo zone of the Amhara region of **Ethiopia**, the Hindu Kush Himalayas (HKH) areas in Takhar and Badakshan provinces of northern **Afghanistan**, and the low-altitude coastal mountainous regions in the city of Port-au-Prince and the island of La Gonâve in **Haiti**. These areas share steep slopes and soil that easily crumbles (friable soil), which are elements that typify mountainous contexts. This topography shapes both the livelihoods of the people who live there and the risks that they face.

DRR activities in these three countries fall into the three categories of **preparedness, natural resource management,** and **structural measures**. For proper risk reduction in mountainous areas, all three categories should be implemented in conjunction with each other.

Preparedness measures includes preparedness for Concern and for communities to respond to emergencies through improved anticipation and response capacity. This includes strengthening community level disaster management committees, linking communities to early warning systems, and improving access to remote communities.

Communities living on mountains can be difficult to access meaning that responding agencies may struggle to reach them. These access issues can and should be addressed through road improvements and investment into alternative transport options (such as pack animals). Having high capacity community committees in place ready to undertake first response, including access to pre-positioned stockpiles, should be strongly considered for mountainous communities. To ensure they are supported, additional efforts should be made to link these committees to the state's institutional structures for DRR.

International, national or wide scale early warning systems are unlikely to capture the nuances posed by the topography and erratic weather in mountainous regions. These landscapes are better suited to smaller scale early warning systems like watersheds. Generally, mountains suit a 'whole of watershed' approach to early warning and natural resource management.

Natural resource management in mountainous regions includes the treatment of slopes with terraces and swales, gully and ravine management with check dams and weirs, and reforestation. Watersheds often span more than one community and, without addressing upstream-downstream linkages and benefit sharing from the beginning, NRM projects are unlikely to succeed.

Successful watershed management requires a combination of hardware and software approaches. Terraces must be planted to be effective, but planted terraces will not 'take' without the exclusion of open grazing, which can require behaviour change. NRM can deliver far more than just risk reduction outcomes, as it can also be used to improve production of fruit and fuel and to reclaim degraded land. NRM should be designed to deliver these multiple benefits, but in mountain contexts, it can be time consuming and labour intensive. It therefore needs to be delivered alongside an incentive mechanism, such as national social protection or cash for work system. Watersheds contain both private and public land, but Concern has struggled to implement NRM on private lands because of an unwillingness to provide incentives to people to improve their own land. This 'patchy' approach to NRM reduces the effectiveness of these interventions in controlling drought, surface runoff, flash floods and landslides.

Structural measures should accompany NRM. These include hazard-proofing essential infrastructure and strengthening natural resource management with engineered walls, weirs and dams. Mountain hazards are intense and mountains often come with significant earthquake risk. Erosion can also be extreme. Without the correct design specifications that provide resistance to peak dynamic loads, structures can fail. While designing for hazards like earthquakes and flash floods is important for all structures, it is especially important for any structure that is essential for humanitarian access (roads and bridges) or where there would be catastrophic impacts should they fail (such as schools).

These measures can cost more, and implications must be clearly understood by donors, who should increase funding allocations for mountainous areas, and Concern, who must guarantee that properly qualified engineers are able to design, guide and supervise all structural measures in mountainous areas.

While this report outlines challenges and approaches specific to mountain areas, elements of mountain vulnerabilities, capacities, and hazards are not unique to mountain areas. Risk in mountain areas is a complex product of poverty, vulnerability, inequality, and hazard, meaning that general DRR principles and practices also hold true and should be adapted rather than discarded for DRR in mountain contexts.

1. Introduction

On 2nd May 2014, two landslides struck Badakshan province, a mountainous region of northern Afghanistan. Triggered by heavy rains, they buried around 300 houses and killed as many as 2,700 people. Over 125,000 Afghans were affected (UN News, 2014). On a visit to the area Mark Bowden, UN Humanitarian Coordinator for Afghanistan, stated: "…when you fly over the area itself, and see how the earth moved and the fragility of the environment here, it highlights the long-term risk to the population in this very vulnerable province and the need for long-term preventive measures" (UN News, 2014).

This report documents how Concern Worldwide uses disaster risk reduction[1] (DRR) to reduce risk and build resilience of the poorest and most vulnerable people living in mountainous areas.

Concern Worldwide is 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. It operates in over 25 countries around the world and takes a multidimensional approach to addressing extreme poverty, and responds to humanitarian emergencies when a community's capacities 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 that can significantly reduce extreme poverty.

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 (below).

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

Concern's understanding of DRR, first articulated in 2005, identifies four components common to risk reduction; risk analysis[2], preparedness, mitigation, and advocacy, which together build community resilience.

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

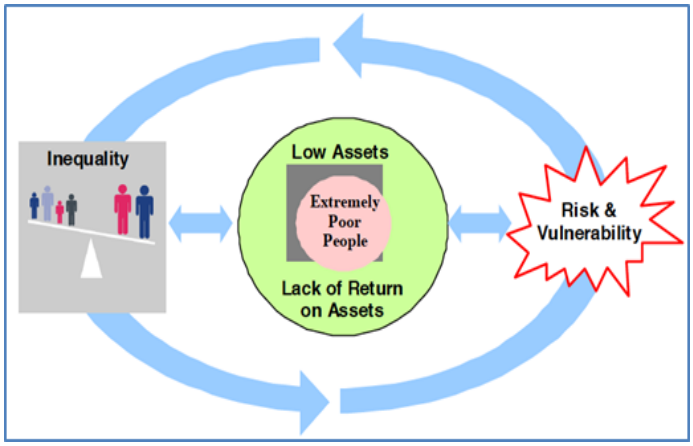


Figure 1: How Concern understands extreme poverty (from Concern, 2010)

2002 was the International Year of Mountains, where it was recognised that mountain regions were a unique and critical geography neglected in policy and practice. Indeed, while mountain-specific approaches may be key to mountain development, knowledge on mountain risk reduction remains scarce and fragmented (Korner *et al.*, 2005; Byers *et al.*, 2013; Smethurst, 2000; Gaillard and Kelman, 2012). DRR is recognised as a necessary component of sustainable development, yet there are few guidelines concerning how to reduce disaster risk in different contexts such as in mountainous contexts (UNISDR, 2011).

Risk is produced at the intersection between humans and their environments (Albala-Bertrand 2000; Cannon, 1994), so analysing risk through a geographical lens can be a way to build contextually specific DRR knowledge. Concern has been implementing DRR in mountain contexts for almost a decade and has developed considerable expertise in the process.

A photo of one of the landslides to strike Afghanistan on 2nd May, 2014 (photo: Fardin Waezi/UN News)

Methods of comparison and structure of the report

To develop an understanding of how Concern reduces risk in mountain contexts, this report systematically compares, assesses, and reviews Concern's DRR activities in the mountain areas of three locations: the Ethiopian highlands, the Hindu Kush Himalayas in Afghanistan, and the coastal mountains of Haiti. These three areas, while all mountainous, also offer a range of different risk contexts, so comparing them provides a means of developing an understanding of good practices in relation to mountain DRR. To facilitate such comparison this report has been divided into four sections:

- The first section introduces the concept of mountain risk and mountain DRR.
- The second section presents and compares each case to identify DRR activities common to mountain areas.
- The third section reviews each activity in detail and develops lessons learned.
- The last section concludes with overall lessons for DRR in mountain 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 (Ethiopia in March, 2013; Afghanistan, May 2013; Haiti, August, 2013), consisting of focus group discussions and key informant interviews of Concern staff, partners, and beneficiaries and collection and review of secondary data.

2. Mountain areas and disaster risk reduction

There is not a consensus definition of what constitutes a mountain region. Mountains have cultural, emotional, and political associations but can also be defined by their technical attributes including elevation, steepness of slope, and volume (Byers *et al.*, 2013). The UNEP (Blyth, 2002), for example, classifies mountains by their slope and elevation, developing six categories in the process:

⇒ *category 6: 4,500m+ elevation*

⇒ *category 5: 3,500 – 4,500m elevation*

⇒ *category 4: 2,500 – 3,500m elevation*

⇒ *category 3: 1,500 – 2,500m elevation and slope > 2°*

⇒ *category 2: 1,000 – 1,500m elevation and slope > 5° or local elevation range > 300m*

⇒ *category 1: 300 – 1,000m elevation and local elevation range > 300 m*

Under this definition, mountains make up a quarter of the world's land surface. They serve as places to live (22% of the world's population lives in mountain areas) and to work, they provide water to around 3 billion people, and they are key for global ecological diversity (Korner *et al.*, 2005; Blyth, 2002).

The geography of mountain areas leads to certain risk profiles, as seen in the hazards, vulnerabilities, and capacities found in mountain areas:

Element of risk	Mountain attribute
Hazard	Exposure to common mountainous hazards like landslides, water erosion, earthquakes and volcanoes, extreme temperature variation, and flash flooding
Vulnerability	Common mountain vulnerabilities including marginalisation from power centres, ecosystem fragility, and poor agricultural lands
Capacity	Access to common mountain resources including water, mineral resources, and mountain based systems of knowledge and culture

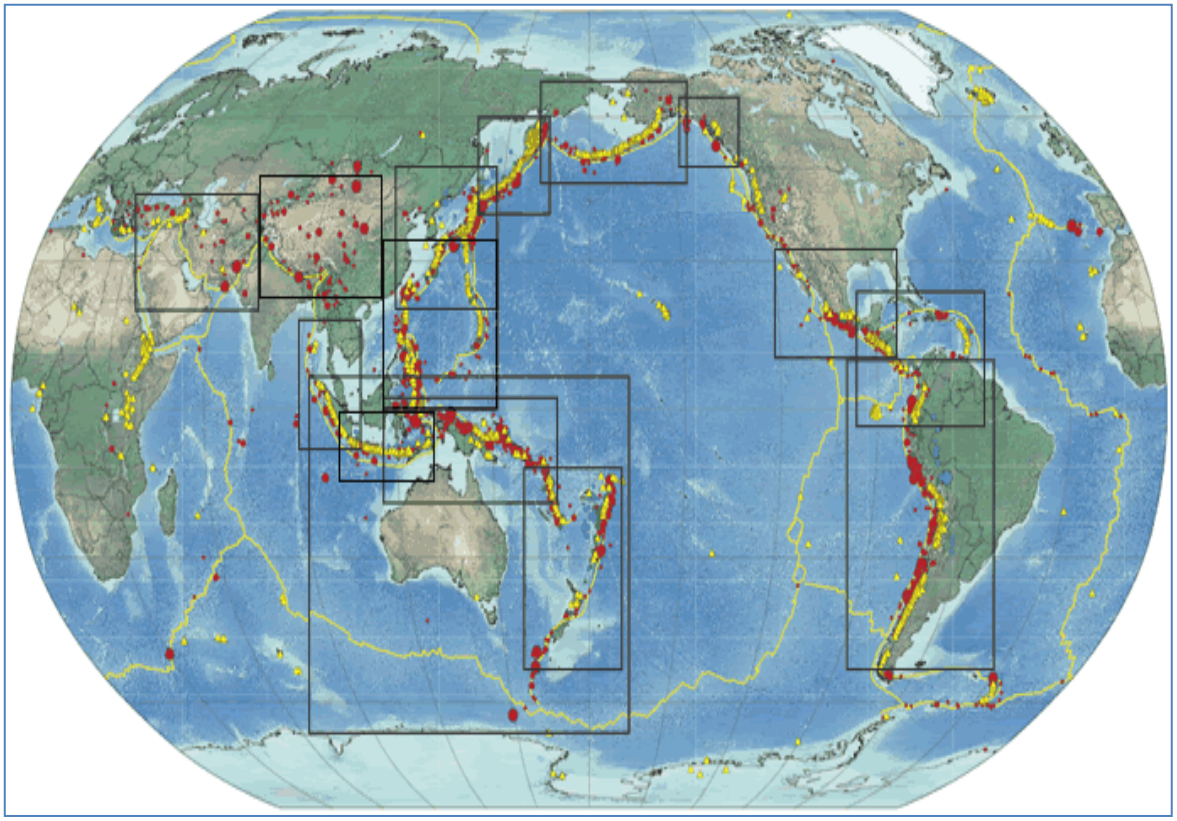
Table 1: elements of disaster risk and their mountain attributes

Approaching mountains from their elements of risk helps provide a more specific and graduated view of mountain risks. For example, some areas might have mountain hazards characteristics (e.g. landslides) but might lack mountain capacities (e.g. knowledge to manage landsides). Other areas might have more mountain capacities and few mountain vulnerabilities. Likewise, some non-mountainous areas may, for example, have steep slopes and be exposed to certain mountain-related hazards like landslides. Indeed, this approach leads to the understanding that mountain risk characteristics may not always correspond to mountain areas and that a strict delineation between mountainous and non-mountainous areas might not be possible or useful. Instead, from a DRR perspective mountain risk areas should be assessed by their hazard, vulnerability, and capacity profiles.

Mountain hazards, vulnerabilities, capacities, and risk reduction

Mountains have unique geographies with specific hazards. They have steep slopes, so are prone to **quick onset and flash flooding**, **landslides**, and **water erosion**. Weather also becomes less predictable at higher elevations, rendering hydro-meteorological disasters more likely. Finally, mountains are the geological 'by-products' of tectonic plate collisions and many are still on active fault lines, meaning that they are often exposed to **earthquakes** and **volcanic eruptions**.

An **earthquake** is a sudden shaking of the ground caused when seismic waves pass through the Earth's crust. Seismic waves are produced when energy in the Earth's crust is released, often when rocks straining against each other slip. Earthquakes mainly occur on fault lines and where there is a thinning of the interior crust.



Map 1: Seismicity of the Earth 1900-2013 (source: USGS). This map shows where earthquakes and volcanoes are prevalent, mainly along fault lines and the fringes of the earth's crust

A **volcano** is a rupture in the earth's crust that can release lava, ash, and gasses. Like earthquakes, volcanoes form along fault lines and where there is thinning of interior crusts. The release of lava, ash and gasses can destroy lives and livelihoods. Sometimes the effects can be extreme: ash from large eruptions can obscure the sun, causing a global drop in temperatures and creating 'volcanic winters'. The 1991 eruption of volcano Pinatubo in the Philippines lowered the global temperature by 0.5 °C for two years (Self *et al*., 1993).

A **flood** occurs when water overflows submerged land that is usually dry. There are three categories of floods: slow onset flooding, quick onset flooding, and flash flooding (EMA, *n.d.*). Slow onset flooding occurs when a large area gradually becomes inundated with water over a prolonged period of time. It tends to occur in flat floodplains, so is uncommon in mountain areas. Quick onset flooding, also called upstream flooding, occurs when water moves downstream at such a fast rate that it causes water to backup upstream. This type of flooding typically occurs over a few days in places in which water flows quickly, and is mainly found in areas with steep elevation changes. Flash flooding results from short and intense bursts of rain, often occurring over a few hours. It can occur anywhere, including in mountain regions.

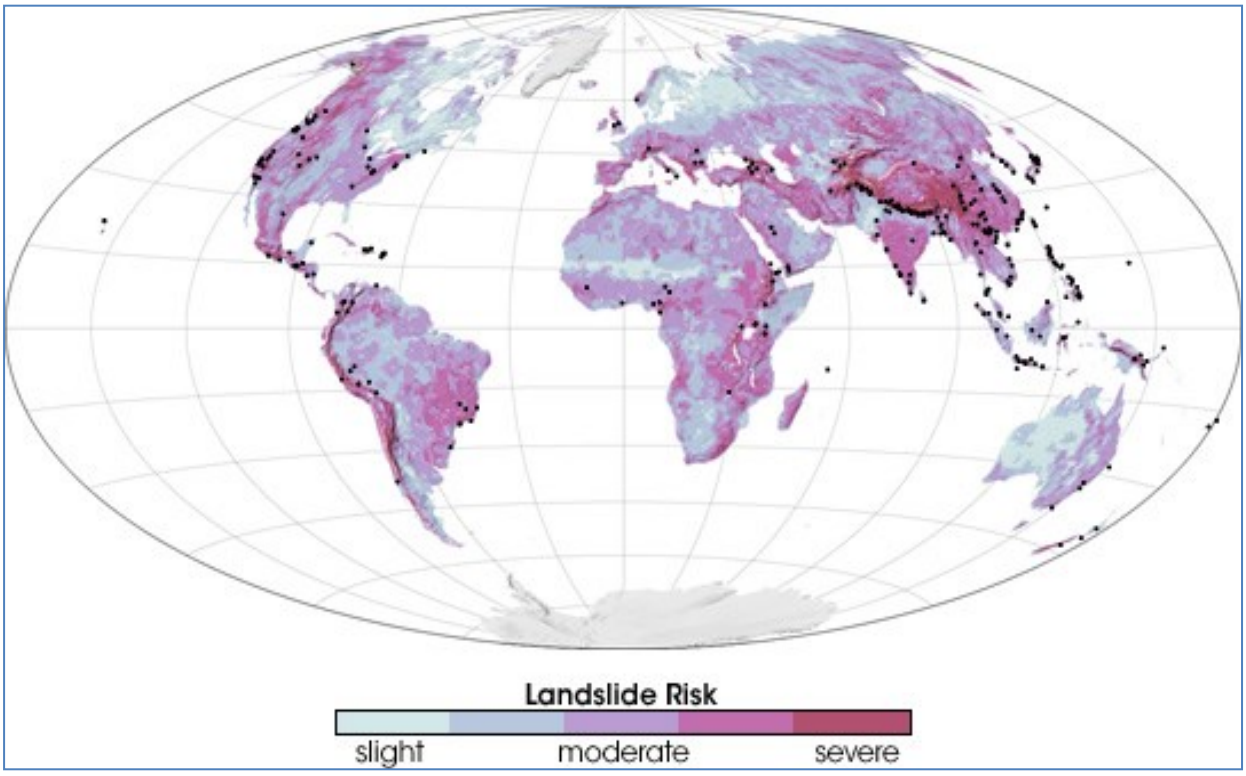
In Badakhshan, Afghanistan, community members scramble to salvage a small hydroelectric power plant from being destroyed due to channel erosion.

A **landslide** is the movement of earth down a slope. Landslides occur when slopes become unstable. Areas with steep slopes, coarse soil, and little vegetation to hold soil in place are most at risk of landslides. As map 2 shows, although landslides can occur anywhere, they tend to be more prevalent in mountainous regions.

Water erosion occurs when water forces overwhelm and wash away soil. Water flow rates, type, and direction as well as soil type and vegetation all influence erosion. Erosion increases as water flows faster, toward soils, and is more turbulent, and flows over more coarse-grained soil, and as vegetation decreases. Water erosion can occur when raindrops hit exposed soil (raindrop erosion), as water moves downhill (sheet erosion and gully erosion), or as it flows through river areas (stream and channel erosion). Erosion can destroy land, deplete soil nutrients, and create sediment build-up in areas where it is not wanted. Mountains are particularly prone to water erosion due to their steep slopes and the fragile soils that are common in mountain regions.

Mountain slopes, elevation, and temperature mean that mountain eco- and agricultural systems are often fragile - indeed, only 78% of mountain areas are suitable or marginally suitable for growing crops (Huddleston *et al.,* 2003). This limited productivity places mountain residents in vulnerable positions. David Smethurst (2000, 36), for example, describes mountains as "economically, socially, politically, and physically peripheral to empires".

Mountains are disproportionately home to the poor, with poverty generally becoming more pronounced the greater the elevation (Smethurst, 2000; Ives and Messerli, 1997; Browne *et al.*, 2004; Korner *et al.*, n.d.). Socially, mountain peoples are often looked down upon as 'backward' or 'primitive' and given derisive labels - whether *hillbilly* in the US, *kohestani* in Afghanistan, or *bhotia* in India (Korner *et al*., 2005). Mountain regions receive little governmental support and are often treated as security or natural resource zones rather than inhabited areas (Browne *et al.*, 2004; Gaillard and Kelman, 2012). Similarly, mountains are a neglected area of academic study, meaning that knowledge of mountain issues is generally lacking (Gaillard and Kelman, 2012; Smethurst, 2000). Finally, residents themselves might engage in harmful practices like deforestation and overly-intensive agricultural activities.



Map 2: global landslide risk map. Areas where large landslides occurred between 2003 and 2006 are marked with black dots. (source: Simmon, n.d.)

While risks in mountain areas can be substantial, mountain peoples have also developed a number of strategies to reduce risk. This includes planting diverse crops to offset erratic weather, managing water resources to ensure equitable and steady supply, terracing to reduce erosion and flash flooding, and community-based disaster response for when disasters occur. These practices have been very effective - in the past, mountain regions were often better off than lowland regions - but many worry that residents cannot adapt fast enough to match the rapid natural and social changes in mountain areas, such as climate change and increasing connections with lowland areas (Hewitt and Mehta, 2012; Price *et al.*, 2013).

Approaches to DRR in mountain areas can be divided into two general categories. The first category, which is guided by what is commonly known as the *hazard paradigm*, treats disaster risk as emerging from nature and to be controlled by technocratic measures. The second category, which is guided by what is commonly known as the *vulnerability paradigm*, conceives of disaster risk as an internal product of both society and nature, which are considered inseparable from each other. Commentators point out that mountains are often viewed as natural places, with risks being considered inherent landscape features (Byers *et al*., 2013; Galliard and Kelman, 2012; Hewitt and Mehta, 2012). Indeed, it is common to approach mountain areas from the perspective of the hazard paradigm that attempts to control both humans and nature. In effect, this results in returning mountain regions and their people to their 'natural' state.

However, a growing body of work influenced by the vulnerability paradigm understands that mountains are not inherently risky places: while risks are influenced by geography, risks are ultimately *human,* not *natural* products, rooted in social and political structures and reflect human decisions concerning how to live (Hewitt and Mehta, 2012; Galliard and Kelman, 2012). For example, local earthquake knowledge in the Central Asian mountain regions is being lost as demographics change, which is increasing earthquake risk in the region despite that hazard remaining the same (Halvorson and Hamilton, 2007).

3. Overview of the mountain case studies and Concern

The northern highlands of the South Wollo Zone of Ethiopia

Concern works in the northern highlands of the South Wollo zone of the Amhara region of Ethiopia, the Hindu Kush Himalayas (HKH) areas in Takhar and Badakshan provinces of northern Afghanistan, and the low-lying and coastal mountainous regions in the city of Port-au-Prince and the island of La Gonâve in Haiti. Concern's programmes in each of these areas are discussed below.

The South Wollo Zone is dominated by the Ethiopian Highlands, a large mountain range that covers two thirds of Ethiopia and has summits as high as 4,550 metres. 2.5 million people live in the zone, and most of them are poor: three-fourths of the total population do not have access to any toilets, incomes can be as low as $200 per annum, and food insecurity can be high. Droughts, disease (plant, animal, and human), landslides, and waterlogging are common hazards in the area. Droughts are particularly devastating as water is scarce and most residents practice rain-fed agriculture. The highlands are part of the East African continental rift zone, a zone of seismic activity exposed to earthquakes and volcanoes, but seismic activity is infrequent in the area.

From upper left, clockwise: the mountains of Ethiopia, Afghanistan, and Port-au-Prince Prince and of La Gonâve, Haiti.

Environmental degradation and an increasing population are placing strain on existing livelihood activities. Residents also note that climate is changing, with rains becoming more erratic and drought increasing in frequency and scale. As a result, community members are increasingly turning to harmful coping practices to survive including temporary migration (which residents state can lead to a breakdown in community structures and increased exposure to HIV, malaria, and other forms of disease), over-exploitation of fodder and other natural resources, and reducing food consumption.

Community members have a number of risk-reducing strategies in place. They plant drought resistant and seasonally appropriates crops and engage in small scale terracing and other forms of resource management (Little *et al*., 2006). Government disaster management systems are becoming increasingly well developed and include a comprehensive early warning system focused on food insecurity and risk reduction planning and intervention process, which is operated in tandem with the Productive Safety Net Programme (PSNP), the government's social protection mechanism.

Concern has been working in Ethiopia since 1973 and today focuses on health, water, and livelihoods. It works with the poorest and most vulnerable, which in South Wollo include female-headed households, landless male youths, and elderly with limited or no social support (Concern, 2011). The organisation also responds to emergencies in the area as they arise and its last emergency response was in 2014 to drought occurring across the Horn of Africa.

The Hindu Kush Himalayas areas of Takhar and Badakshan provinces, Afghanistan

Afghanistan, like Ethiopia, is a poor country, ranking 169 out of 187 in the 2014 Human Development Index, a measure of development. It is also highly insecure, and has been experiencing continuous conflict since 1978 when the government was overthrown in a violent military coup (UCDP, 2015).

Concern works in Takhar province (population 933,000) and Badakshan province (population 904,000) of Afghanistan, both located in the northeast corner of the country. The provinces border the Hindu Kush Himalayas (HKH), Asia's largest mountain system and home to the highest mountains in the world. Common hazards for the two provinces include floods, extreme temperatures, earthquakes, disease, drought, and conflict. Rising populations, widespread environmental degradation, and an influx of foreign aid and investment have been causing changes in the areas, including a shift away from agriculture towards other forms of work. Many of these changes are conflict related: deforestation and environmental degradation, for example, were both coping strategies used during times of conflict.

Communities in Takhar and Badakshan also have a number of strategies in place for managing risk, such as designing buildings to withstand earthquakes and managing land in ways that minimise environmental degradation. Community level customary governance structures are also important: intra-community ties are strong and it is common for households to support each other during and after disaster. Community help is further codified in Islamic traditions of charity (*zakat*) and tax (*ushr*), which provide a customary legal framework. Nonetheless, certain social practices also increase risk. Gender discrimination is rife, and women have less access to economic, social, and political resources than men, including those resources crucial to reducing risk (Bhargava, 2014). For example, Thapa (2009) has found that in Afghanistan women are more likely than men to drown during floods because they are less likely to know how to swim and wear more restrictive clothing.

The government also plays a role in DRR in the country, much of it through the Afghanistan National Disaster Management Authority (ANDMA), the agency mandated to coordinate disaster management, from mitigation and preparedness to response and recovery. ANDMA works mainly at national level, with local level activities being implemented through Community Development Committees (CDCs), the local governmental bodies responsible for implementing government policy.

Concern started working in Afghanistan 1998 in response to an earthquake in the northern region of the country and today focuses on livelihoods; water and environmental health; education; and women's empowerment. The organisation operates mainly at community level and works closely with both customary and formal governance structures. As in Ethiopia, Concern responds to small and large-scale disasters as they arise.

The coastal mountainous regions in the slums of Port-au-Prince and on the island of La Gonâve in Haiti

Haiti is an island country located in the Caribbean, consistently ranked as the poorest country in the Americas and the Western hemisphere. Port au Prince is the country's capital and La Gonâve is a small island within the city's official administrative boundaries, but located off the city's coast. Neither of the areas can officially be considered mountainous as they are both below 300 metres in elevation, however they both have steep slopes and rapid elevation changes and are exposed to common mountain hazards. In addition, the areas are coastland so also experience coastal hazards as they are only a few hundred metres in elevation. Some of the main risks in the areas include landslides, flooding, earthquakes, droughts, hurricanes, and disease, including cholera. Gang related conflict and criminality is also prevalent, both at national and local levels, with most of the local level conflict occurring as part of gang warfare in the slums of Port au Prince. Environmental degradation, including widespread deforestation, is also extreme.

Concern has found that in Port au Prince poverty - and risk - is concentrated in the poorer inner-city neighbourhoods, with many located in geographically marginal areas with little access to key services. Concern works in two of the slums, St. Martin (population 70,000) and Martissant (population 200,000). Poverty and risk is also high in La Gonâve, although the dynamics of poverty differ: in Port au Prince rates of unemployment and marginal employment are high, with most residents engaging in petty trading as a source of income, if they work at all. In La Gonâve most people rely on agriculture, forestry, and fishing as sources of income. Gang related violence, earthquakes, and hurricanes are the main hazards in Port au Prince while in La Gonâve drought and hurricanes pose a greater threat. Because of the differences in poverty and vulnerability, Concern interventions differ between areas. Urban interventions focus on peace building, improving urban livelihoods, and supporting changes in urban governance and policy. Rural interventions focus more on agriculture, fisheries, and improving water points. Nonetheless, many of the interventions address similar hazards pertaining to earthquakes, storms, drought, and cholera and have a similar community focus while also working to support national DRR policies and operations.

Discussion

The mountainous areas of Ethiopia, Afghanistan, and Haiti have certain commonalities in their poverty and risk profiles, but also have some key differences. Common hazards include earthquakes, diseases, floods, and landslides. However, frequency and impact varies between countries: the highlands of Ethiopia have earthquakes but they are minor compared to those in Afghanistan and Haiti, for example. Likewise, some hazards can be found in some areas but not others: malaria can be found in Haiti but not the highlands of Ethiopia. The geography of the areas influences these hazard characteristics. All have steep slopes and are located on active fault lines, resulting in earthquakes, landslides, flash floods and soil erosion.

4. Concern's approach to disaster risk reduction in mountainous contexts

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 into all sectors and programmes 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 and 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.

These components are common to all DRR activities, including those in mountain regions. For the mountain regions of Haiti, Afghanistan, and Ethiopia, Concern's specific DRR activities include:

Preparedness

UNISDR (2009) defines preparedness as "the knowledge and capacities developed by governments, professional response and recovery organizations, communities and individuals to effectively anticipate, respond to, and recover from, the impacts of likely, imminent or current hazard events or conditions."

Natural resource management (NRM)

Natural Resources Management (NRM) is described as "the sustainable utilization of major natural resources, such as land, water, air, minerals, forests, fisheries, and wild flora and fauna" (World Bank, 2000). In mountain contexts, Concern uses NRM for vulnerability and hazard mitigation.

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). As with NRM, Concern implements structural measures as a form of risk mitigation.

The next section compares these activities in detail.

Preparedness

Disasters can occur anywhere - even in countries with considerable resources for risk mitigation like the United States and Ireland - meaning that preparedness is always a necessary component of DRR. As such, Concern prepares for disasters in all of the countries in which it operates. Concern is engaged in preparedness in the mountain areas of Haiti, Afghanistan, and Ethiopia in the following ways:

Commonalities in preparedness

- Risk analysis to develop knowledge and plans
- Hazard speed, impact, and response ability influence preparedness activities
- Internal preparedness through *Preparing for Effective Emergency Response* (PEER)
- Community-level preparedness
- Early warning systems

Differences in preparedness

- Preparedness is community-centred (Afghanistan and Haiti)
- Preparedness is government-centred (Ethiopia)
- Localised contingency funds and/or stocks (Afghanistan and Haiti)
- Improving access (Afghanistan and Haiti)
- Hazard specific early warning systems (Afghanistan, Haiti)

In all cases Concern starts with risk analysis to develop knowledge and plans, works to build its own preparedness, the preparedness of communities, supports early warning systems, and has contingency funds in place (held at head office) for emergency response. It considers preparedness to involve two components: building preparedness of partners - both government and community - and building the preparedness of the organisation itself. Some of the more specific ways it operationalizes these activities, however, differ, and reflect the various hazard, vulnerability, and capacity profiles of the areas.

Internal preparedness

As a humanitarian organisation Concern will 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

Concern offices in Ethiopia, Afghanistan, and Haiti all have developed PEER plans; Ethiopia's initial engagement with the PEER process dates from 2011 and Afghanistan and Haiti from 2012.

Concern uses a variety of tools for its emergency responses in mountain areas. It frequently employs cash for work (CFW) to provide support to vulnerable households affected by emergencies. It used CFW in Afghanistan as part of its 2010 drought response, in Ethiopia as part of its 2014 drought response, and in Haiti as part of its 2012 Hurricane Sandy response. Communities themselves select work projects and many have risk reduction outputs. Projects in Afghanistan have focused on improving transportation and protecting essential infrastructure, projects in Haiti have included constructing hazard-tolerant shelter and essential infrastructure, and projects in Ethiopia have focused on terracing to redue erosion and flooding risk.

Concern also addresses health assets: in Ethiopia it trains health workers to address spikes in malnutrition - a programme run in conjunction with the Ministry of Health. In Haiti, however, while Concern provided toilets, sanitation training, and other WASH activities in response to the cholera epidemic that started in 2010, it was not prepared for the epidemic itself as it was an unanticipated disaster. This reinforces the importance of PEER in changing mind-sets and building general preparedness rather than just preparing for the occurrence of specific hazards. Lastly, when disasters affect physical assets, Concern supports reconstruction, rebuilding, and infrastructure development directly and through the provision of non-food items including shelter materials, cooking sets, and winterisation kits, which may include clothes, stoves and fuel.

The extent of isolation and the hazard type influences how Concern prepares for emergencies. In Afghanistan and Haiti, Concern invests in pre-positioned stocks to improve its responses to sudden-onset hazards in cases where access is challenging. The organisation is able to respond to most small-scale and large-scale emergencies in as little as three days in Afghanistan as a result of this work. Such stocks are less necessary in Ethiopia as the main hazard – drought - is slow onset and access is less difficult, making timely response easier. Rapid responses may however be hindered by high transport costs, staff turnover, and limited resources.

Preparedness of other stakeholders

Concern recognises that its governmental, non-governmental, and community partners also have key roles in emergency responses. In mountain regions the organisation works to build the preparedness of other stakeholders through establishing, organising, training, and funding local-level disaster management committees (DMCs), the official governmental structures of the country responsible for risk reduction.

Concern staff in Afghanistan have found that early response can often be preventative. The picture above shows a community watching as a flash flood bears into their village causing erosion. Without intervention the flood would cause more damage, including destroying the water point (right foreground). Concern, fortunately, has funds in place to respond to these emergencies quickly and was able to build a small protective embankment to divert water flow away from the area, preventing further erosion. Staff noted that this approach can be challenging, as donors often wait until an emergency has occurred to provide funds.

DMCs have a legal foundation in the three case study countries but differ in their specific composition. Afghan DMCs blend customary and government bodies to the extent that the terms *shura* (leadership structures outlined in Islamic law, in Afghanistan mainly being community councils of elders) and community development committees, or CDCs (government-designated community level structures) are used interchangeably. In Haiti, DMCs are linked to the National Red Cross Society and are run by elected volunteers. In Ethiopia, committees are state entities run by government officials.

These configurations - both on paper and in practice - determine how Concern strengthens broader institutional structures. In Ethiopia, structures are well-developed and state-centred, so Concern focuses on information sharing, while in Haiti and Afghanistan Concern establishes and trains committees and provides funding for response since committees, while outlined in policy, do not always exist in practice. Training covers the entire disaster management cycle, including participatory risk analysis, preparedness (contingency planning, identification of the vulnerable, evacuation planning), and mitigation. In Afghanistan, communities have traditional early warning systems, contingency plans, and self-help mechanisms for response based on the concept of *zakat* (charity codified under Islamic law), while in Haiti such self-help is less apparent (this however varies per village).

This photo shows a risk map produced by communities in Afghanistan. Risk maps are designed to help understand the risk context. They show the hazards (marked in red), the settlement areas, and the structures in place to reduce the hazard. This map reveals that floods and erosion pose large risks to the area, but that trees and embankments are in place for reducing risk. The risk analysis process is as important as its outcomes: the maps are created using a participatory technique that helps gather community perspectives on what the risks are and galvanise communities to action.

To capture all perspectives, analysis must be delivered in ways that are inclusive to everyone in the community. In Afghanistan women are often marginalised in decision-making processes. Concern is specifically targeting women by creating women's groups and employing men and women as community mobilisers, however staff still worry that they let (male dominated) CDCs take too much control in risk assessment and problem identification.

	Ethiopia	**Haiti**	**Afghanistan**
Who is responsible for preparedness?	The state	The state through Red Cross managed committees	The state through *shuras*/ CDCs
How does Concern build the preparedness of partners?	Gathers information and assists in the analysis of risk and vulnerability	Analyses risk, provides training, tools/ equipment, and funding	
What impact do these activities have?	More information improves ability of state to respond	Enhanced ability of community to respond. Self-help capacity enhanced. Limited sustainability due to low self-help	Enhanced ability of community to respond. Self-help capacity enhanced. Some sustainability due to greater self-help capacity.

Table 3: How Concern builds community preparedness in mountain contexts

Indeed, in Haiti and Afghanistan communities are mostly on their own when it comes to preparing, coping with and responding to disasters, while in Ethiopia the state manages preparedness and response - a system that can be efficient but means that Concern can only respond once the state officially declares an emergency. Table 3 summarises how Concern builds community preparedness:

Contingency funds

There are a number of funds that Concern can access 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 two contingency funds held by DfID (Rapid Response Facility and the START fund).

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.

Early warning systems

Early warning systems (EWS) refer to the capacities to generate and disseminate warning information that allows for timely preparedness and action (UNISDR, 2009). Concern supports both community-based and centralised EWS. This choice depends on data resolution needed, hazard type, and existing EWS in place. Table 3 shows the ways in which Concern supports EWS in Haiti, Afghanistan, and Ethiopia.

Ethiopia has a well-developed multi-hazard EWS at the national level, so Concern mainly supplies data to this system from the areas in which it works and helps to analyse information at regional levels. National EWS is not as developed in Haiti and Afghanistan, so Concern supplements these systems with global systems like Famine Early Warning System Network (FEWS NET), an EWS focused on food security, and with local systems, including storm warning systems based on local meteorological station data (in Haiti), and a community-based flood EWS developed in partnership with ActionAid (in Afghanistan).

	Ethiopia	**Afghanistan**
Who is responsible for EWS?	The state	The state through *shuras*/DMCs
How does Concern build EWS?	Gathers information about all hazards and provides it to the state	Sets up information collection mechanisms for flood Transmits information downstream Provides communities with means communicating information Sensitises communities to respond
How does the EWS work?	State and partners collect information on all hazards State compiles and assesses information State declares emergency State, non-state actors respond	Communities collect flood information upstream Communities relay information downstream using mobile devices Downstream communities issue a warning Vulnerable residents respond to announcements Residents, NGOs, respond to warnings
What impact do these activities have?	More information improves ability of state to respond	Improved data collection Improved warning dissemination Better response

Table 4: How Concern supports EWS in Ethiopia and Afghanistan

EWS only work if warnings are properly communicated and then acted upon. In Ethiopia, EWS information, while advanced, is rarely communicated downward, so while Concern itself is able to plan, prepare, and respond to emergencies in a timely manner, local communities are not always able to do so as they do not have the necessary information. In Afghanistan and Haiti, disaster information is often communicated via radios or relayed through DMCs using megaphones (in Afghanistan mosque loudspeakers are used, and in Haiti DMCs have their own megaphones). These systems cover immediate geographic areas but might not reach everyone: in 2011, for example, a landslide occurred over an eight-hour period in a market area in Afghanistan. While local shopkeepers were able to remove their goods from stores, shop-owners outside the local vicinity were not notified and did not remove their wares and suffered greater losses as a result.

In Afghanistan, geographic and climatic conditions, namely erratic climate and mountainous topography, reduce the accuracy of nationalised weather data in predicting localised floods. This necessitates a localised flood EWS. Concern has developed a flood EWS in the country in response to this challenge. Information is collected at the level of hazard creation - at watershed level – collated by Concern, and transmitted and spread by DMCs using microphones, loudspeakers, and other equipment.

Improving access

Floods, landslides, snowfall, earthquakes and other hydro-meteorological and geological events often disrupt transportation in mountainous areas. Winter snows can accumulate in drifts up to six storeys high, cutting off rural Afghani villages for up to six months during winter (Dobbin, 2012). Some 'roads' in the slums of Port-au-Prince are actually dry riverbeds, which flood during heavy rains. Some of the coastal communities of La Gonâve are not even accessible by road and members instead travel by boat when the ocean is calm. Likewise in Ethiopia, roads, while often well constructed and maintained, do not reach all settlements, increasing the challenges of emergency response (Nyirenda and Belachew, 2010).

Roads in Afghanistan (left) can be treacherous in winter. Riverbed paths in Port-au-Prince Prince (right) flood when it rains.

Concern improves access in mountain areas by improving roads, using alternative transport, and pre-positioning stocks in strategic locations so that even if the roads are not passable, essential supplies can be accessed. It focuses on improving transportation, mainly in Haiti and Afghanistan as transportation infrastructure is poor in both these areas and disasters often occur suddenly, necessitating rapid responses. Besides improving response, roads can help communities access schools, health centres, markets, and other services; in Haiti and Afghanistan, Concern works with DMCs to improve roads using cash for work as part of post-disaster recovery operations and as a specific preparedness activity. When settlements are inaccessible by motor vehicle, Concern uses alternative means of transportation for response. In Afghanistan and Haiti it rents pack animals to transport supplies over mountainous terrain. In coastal regions of La Gonâve, Concern responds with motorboats and has also supplied DMCs with boats.

Lessons to be learned for preparedness in mountain areas

Concern improves preparedness in mountain areas by strengthening community preparedness, as well as preparing for and responding to emergencies itself.

The PEER process has shown that while Concern can identify and plan for anticipated 'normal hazards' in mountain areas, there is no assurance that it will only be those hazards that occur. PEER plans must **give priority to preparedness activities that improve the capacity to respond to *any* disaster event** – even those that are unexpected (such as cholera in Haiti).

Given the topography of mountain areas, it is likely that there are some places that are difficult to access – and may even be cut off (such as during winter in Afghanistan). Where there are access issues, Concern or other responding agencies may not be able to quickly reach affected communities. **Prepositioning of stocks and training community members**, such as members of the disaster management committee, to be 'first responders', is therefore necessary.

Concern needs to **improve transportation in order to guarantee humanitarian access**; this can be done by improving roads or by assessing alternative forms of transport – like pack animals (such as in Afghanistan) or boats (such as in Haiti), depending on the environmental constraints posed. Addressing access can create secondary benefits – cash increases the amount of money in the local economy, and improved access also increases all-season access to markets, schools and health centres.

Disaster management committees must be truly representative of the community. This must **include all community institutions that have influence in the community**, which means any customary or traditional leadership structures; especially important in remote areas where the reach of the state is less apparent. However, all efforts must be made to link community DMCs to the state DRR institutional system. Where policies exist on DMC structure and function, these must be followed. In cases where this policy guidance does not exist, Concern should provide guidance on committee structure, roles, and responsibilities. Preparedness should be for multiple hazards and not just focus on hydro-meteorological ones as is often the case in mountainous areas. Haiti has shown clearly that other hazards – earthquakes and cholera – can also happen; and must be take into account.

Early warning systems are critical features of preparedness, and where they exist they should be monitored and factored in to all planning processes; and if possible, Concern should contribute to them through a variety of possible actions such as data collection and analysis. Even where there are no national EWS there are often international ones that can be accessed – like FEWS NET.

All EWS must follow the four principles of an EWS, namely: understanding the hazard; reliable and timely warning services; transmission of warnings to vulnerable communities; and assisting communities with preparedness planning so that they know what to do in the event of a warning. Where access is difficult and beyond the reach of mobile phones, alternative communication methods should be used – like the mosque loudspeakers in Afghanistan and megaphones in Haiti; but these systems must be backed-up with efforts to get the messages beyond the reach of aural systems, to ensure that all vulnerable people access warnings.

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Overall, a number of lessons can learned from analysing this work:

- Preparedness in mountain areas has a number of common components, including internal preparedness, community preparedness, early warning systems, and contingency funds.
- The specific methods of operationalising those components differ depending on the institutional configurations and hazard profiles of mountain regions.
- Access can be challenging in mountain areas but can be mitigated. Often, this is as simple as improving roads and paths. However, in areas where snowfall is extreme, this might include using alternative transport like pack animals.
- Given access limitations in mountains, it is often necessary to pre-position stockpiles of essential response materials near or within isolated hazard-prone communities. For similar reasons, the presence and capacity of DMCs is important in isolated areas.
- Preparedness efforts often focus on hydro-meteorological hazards, with preparedness of other hazard types differing on the basis of risk and institutional profiles.
- EWS need to monitor at the scale of hazard creation and to be communicated at the scale of hazard realisation. This means that because of topography flood EWS must be localised.
- Access to information is key to EWS effectiveness.

Natural resource management

Natural resources provide a number of services to those living in mountain areas. They can reduce the scale and frequency of hazards, offer protection from hazards, and can be used for livelihoods, which can decrease vulnerability and improve capacity. Recognising the importance of NRM in mountainous areas, Concern uses it as a DRR mechanism in Haiti, Afghanistan, and Ethiopia, including:

Commonalities in NRM

- Hazard type, land use pattern, and settlement location influence NRM activities
- Watershed management
- Terracing and swales
- Sustainable agriculture and forestry
- Intensifying land use
- Constructing check dams
- Cash for work
- Governance challenges

Differences in NRM

- NRM is community-centred (Afghanistan and Haiti)
- NRM is government-centred (Ethiopia)

As with its preparedness work, Concern performs similar NRM activities across contexts - including watershed management, building check-dams and terraces, and supporting sustainable agriculture and forestry. In all countries, NRM activities are arranged along watershed lines to reduce hydro-meteorological risks. They also help address geological hazards related to soil erosion and landslides.

How Concern selects its specific NRM activities

Settlement location, hazard type, and land use pattern influence how Concern selects its specific NRM activities. In hilly areas close to settlements prone to hazards like landslides, erosion, and floods, Concern adapts intensive forms of NRM consisting of constructing terraces (flat, often long, areas that resemble steps) and swales (flat half-moon structures similar to terraces) and planting trees (fruit trees for markets, fast growing trees for fuel) and grasses (selected on their ability to stabilise soils as well as provide fodder). For hazard prone areas away from settlements, less intensive NRM is practiced, mainly consisting of terracing and planting fodder. In areas that are far away and relatively less hazard prone, Concern might select very basic NRM consisting of preventing uncontrolled grazing through fencing. Specific hazards influence site selection: drought is a major hazard in La Gonâve, so NRM is focused on improving water availability. Ethiopia is similar, with sites being selected to improve drought resilience. NRM in Afghanistan, on the other hand, is frequently employed to address landslide and flooding hazards in addition to drought.

Concern adopts a range of NRM strategies in Afghanistan. The picture on the left is an example of an intensive NRM approach consisting of gardening and swales. The intensive approach was chosen to reduce landslide risks and because the land was close to the village, making it easily accessible for high-intensity labour. The picture on the right is an example of less intensive NRM - simple fencing and sectioning off of land. This approach was selected for similar reasons (to improve the watershed, build livelihoods, and stabilise soils), but activities were less intensive as land was located further from the village.

Types of land targeted for NRM

Concern targets both unused and used lands for intensification. Some land may not be used for cultural reasons (in Afghanistan, cemeteries often have good land that the local population is happy to use for agriculture) or because it is degraded (residents have overused agricultural lands in all countries; in Afghanistan warring factions have also cut down trees during conflict for fuel and as a source of income). Developing unused land - cemeteries and degraded land - allows Concern to improve livelihoods and reduce risks with few additional costs beyond inputs. Accessing unused land is important when settlement densities are high and most land is already used.

Intensification of used lands involves shifting from activities that may degrade land and only offer few services - in all countries this includes monocultures with uncontrolled grazing on steep slopes - toward activities that improve land and offer greater services. This can include controlled grazing, gardening, and agroforestry. In all cases, Concern targets community and government owned lands, and works to convince farmers of the value of intensification for their individual plots. While this is important in making sure that the interventions reach the poorest and most in need, managing *all* lands within a watershed is important for improving the watershed, so in cases where large amounts of land are privately held such work can have little impact on watersheds.

The process of NRM

Concern follows the same general practice for its NRM: the organisation first constructs terraces or swales on steep-sloped hills with friable soils and little groundcover, and then proceeds to build check dams in gullies, followed by plantation of the areas. Terraces, swales, and check dams work to slow the flow of water and prevent erosion, but Concern constructs terraces and swales first because they help slow the flow of water into gullies. Large, fast flowing volumes of water can cause check dam destruction, and check dams can be easily damaged during terrace and swale construction. Concern constructs terraces in areas with low to moderate slopes, and swales in areas of steeper slopes as water can flow at high enough rates to destroy terraces, but can flow between swales (this depends on how the flow is directed - in Asia rice terraces can be found in areas with very steep slopes, even above 45 degrees). It uses simple measurement tools to space terraces and swales in even rows, as even spacing on contour lines is key to reducing their likelihood of collapse. Once terraces and check dams are constructed, Concern plants fodder crops and trees; the process is labour intensive but leads to quick regeneration and soil stabilisation, reducing chances that structures will collapse. Ideally, staff with technical expertise should regularly assess the work to ensure that it is in line with good practice, however staff time is sometimes limited in this regard. Lastly, Concern closes off these lands for a period of time (often a few years) to allow fodder and trees to stabilise and grow. This step is vital because plants can easily be destroyed by open grazing in their initial stages of growth.

NRM can be labour intensive and the mobilisation of workers varies by country. In Ethiopia, Concern connects programme participants to the government's Productive Safety Net Programme (PSNP), a social protection mechanism that provides cash transfers to chronically food insecure people in exchange for 60 days' labour as a way of incentivising and speeding up the work. In Afghanistan, Concern provides cash for work during times of crisis in addition to using CDC for mobilising voluntary labour. In Haiti, it relies on a number of organisations for the mobilisation of paid and unpaid work but, compared to Afghanistan and Ethiopia, is slower to convince community members to participate in unpaid labour. In all cases, providing cash can help reduce negative coping strategies that contribute to degradation and can speed up work. However, providing cash may also mean that communities are less invested in the intervention results.

Lands can be spread out and therefore difficult to physically guard, so Concern works to ensure land management practices are respected without the need for policing. In Ethiopia and Afghanistan, community members use guards and fences to help ensure lands are not used while they are being regenerated. In both cases, such efforts are not enough to prevent anyone with determination from using these lands. However, Concern has found that community members will not use the land if light social policing is in place. In both cases, communities select guards based on their poverty levels, paying them a small salary in exchange for their services, and in Afghanistan guards sometimes double as gardeners. In Ethiopia, these guards are exempt from the 60 days' obligatory labour to receive the PSNP but can still draw their allocation if they choose to work throughout the year. These various processes are summarised below:

Concern's approach to NRM in the mountain regions of Ethiopia, Haiti, and Afghanistan

Ethiopia	Haiti	Afghanistan
• *Identify participants through PSNP* • *Select slopes for treatment based on livelihoods and drought using the watershed as unit of analysis* • *Mark out terraces* • *Engage residents through 60 day government labour allocations and volunteering to construct terraces and check dams* • *Plant with fodder crops* • *Improve water points* • *Exclude livestock using guards* • *Single harvest of fodder*	• *Identify participants through DPC committees* • *Select valleys for treatment with check dams and terraces to counter drought and improve water supply in downstream sources* • *CFW offered as a community incentive* • *Attempt to get community exclusion of livestock but a failure due to land ownership context and a lack of community policing* • *No planting of additional plants; considered too difficult without more water* • *Limited effectiveness*	• *Identify participants through CDCs* • *Select slopes for treatment based on floods, landslides and livelihoods using the watershed as unit of analysis* • *Engage residents through customary zakat and CFW to construct terraces and check dams* • *Plant with fodder and fruit bearing trees* • *Exclude livestock with fencing and guards, using guards as gardeners* • *Harvest fodder*

Governance challenges

All countries face NRM governance challenges, many related to inter- and intra- community land management. Most of the land in La Gonâve is remotely owned, and owners rent land to whomever pays. Users of upper catchment lands have few incentives to sustainably manage these lands if the main benefits are realised downstream from where they are, so they practice intensive grazing and other activities that increase degradation. Concern's NRM activities in Haiti are limited to building check dams and terraces to improve the quantity of water in springs—activities that focus on small geographic locations, not larger ones like terracing and increased provision of fodder. In Afghanistan, community land management systems can be strong (for example, upstream water users sometimes provide their downstream neighbours with labour in exchange for higher water use, and *shuras* can easily control communal land), but cross-community land management can be weak. Likewise in Ethiopia, communities are able to manage their own lands but have little ability to work with and negotiate with those from other areas (in one case downstream water users were worried about upstream water consumption by businesses). Additionally, since Concern's work is connected with the PSNP, a public programme, it mainly focuses on public lands. The organisation is planning to expand to private lands but acknowledges that to do so it will have to be under different incentive structures. The work is further hampered by the lack of long term land tenure – residents can lease land but ultimate ownership resides in the government. This reduces the incentive to invest in land improvements (Devas, 2006).

Cross-community NRM can be challenging. The fields pictured in Afghanistan are used to grow wheat, but given their steep slopes and friable soils should be planted with fodder and trees to avoid erosion, flash floods, and prevent growth of the large gully located below. These agricultural practices are creating a large risk for the village below (not pictured), but landowners are from a different village and have little incentive to protect the land for risk reduction.

Lessons to be learned for NRM in mountain areas

Many in mountainous regions rely on the services that natural resources provide to reduce disaster risk, meaning that NRM is a crucial component of mountain DRR.

Mountainous topography lends itself to a **'whole of watershed' approach**, and NRM can be used to mitigate flood, drought, erosion and landslide risk. NRM can be used to address multiple issues simultaneously – such as land reclamation, poverty alleviation and risk reduction.

In watersheds that span more than one community's jurisdiction, the **upstream-downstream linkages and benefit sharing must be addressed** through the establishment or strengthening of common governance structures. Where customary systems exist, such as in Afghanistan, they can be used for strengthening benefit and maintenance sharing between communities in a watershed. The government can guarantee cross-community cooperation in situations where the government is strong, such as in Ethiopia. Haiti shows how, without addressing these linkages, NRM is likely to have limited success.

For NRM to be successful **it must include a component of behaviour change** aimed at removing or reducing some of the underlying causes of environmental degradation. In each of these cases uncontrolled grazing was an important factor preventing natural regeneration of vegetation. Where open grazing was excluded land could be successfully regenerated.

Watershed management work tends to happen on public, communal or state land, but for the most successful watershed management, all slopes should be treated – including those under private ownership. **Concern should determine suitable mechanisms for also treating private land** that do not clash with Concern's targeting policy of working with the extreme poor.

There is a clear order of activities for the treatment of a watershed, starting with analysis; **risk analysis must be done at the same time as analysis of land use patterns**, markets and production systems. This has the effect of focusing NRM interventions on priority high risk areas.

The construction of terraces or swales along contours should be the first activity to be addressed in NRM interventions in areas with steep slops, followed by building check-dams in gullies. **Terraces must be planted** with trees and/or fodder crops, or they are likely to be ineffective and possibly collapse. For the plants to survive, **open grazing must be prevented**.

NRM in mountain regions is time consuming and labour intensive, and so **needs to be supported with incentives**. When a government safety net system exists, as in Ethiopia, it should be used, but when safety nets are not available, cash for work might be required.

The following general lessons can be learned from Concern's NRM work in mountain contexts:

- NRM in mountain areas should always include watershed management.
- Mountains, due to their topography, are more suited to a 'whole of watershed' approach.
- The construction of check dams and terraces is a technical activity that requires expertise. Greater care must be taken as slopes increase.
- Cross-community and whole of watershed approaches may be necessary to reduce erosion, flooding, and drought hazards, but can be difficult without common governance structures.

- NRM focused on watershed management can be used to improve water supply, so should be included in any activities focused on building drought resilience.
- The causes of resource degradation should inform NRM strategies. Sometimes, resources are degraded as part of a coping strategy; if this is the case, NRM should be tied with livelihoods support, e.g. cash for work.
- As seen by the increase in deforestation in Afghanistan related to national conflict, connecting mountainous areas to lowland areas can exacerbate degradation and lead to new risks.
- Differentiating between areas based on risk and livelihood patterns can help create contextually appropriate interventions.
- NRM committees can help manage community owned lands but might not be as effective in improving private land management.
- Communities often have their own customary natural resource management practices that influence how activities are implemented. Care needs to be taken to understand and work with these systems.

Structural measures

Depending on their construction, structural measures can be a source of risk or of risk reduction. Well-built hazard-tolerant structures can offer protection from storms, earthquakes, landslides, erosion, and other events, but structural failures can create additional damage and lost lives. Concern uses structural measures to reduce risk in Ethiopia, Afghanistan, and Haiti, including:

In all countries, Concern works to hazard-proof its irrigation and water points and builds check dams and weirs. However, in Haiti and Afghanistan the organisation works on a number of specific measures including constructing floodwalls and embankments, hazard proofing roads and shelters, and bioengineering. The purpose of check dams, weirs, floodwalls, embankments, and bioengineering is to reduce the intensity and impact of hazards, while Concern 'hazard proofs' roads, houses, WASH facilities, and other structures to reduce the damages they may sustain. Across countries, it mitigates the physical impact of hazards, including landslides, earthquakes, erosion, floods and storms, with structural work involving better design, construction, and maintenance.

Commonalities in structural measures

- Hazard-proofing irrigation and water points
- Check dams and weirs

Differences in structural measures

- Hazard-proofing shelters (Haiti and Afghanistan)
- Hazard-proofing latrines (Haiti)
- Hazard-proofing roads (Haiti)
- Floodwalls and embankments (Haiti and Afghanistan)
- Bioengineering (Afghanistan)

Hazard-proofing structures

Structures need to withstand extreme events as well as gradual wear and tear, so Concern works to hazard proof the structures it builds. This involves building structures to withstand *predicted dynamic loads*, e.g. loads caused by earthquakes, floods, soil pressure, extreme wind speeds, and other hazards. There are few engineering guidelines or codes in Afghanistan, Ethiopia, and Haiti, and those that exist are poorly enforced, so Concern follows international engineering standards such as standards developed by the International Federation of Consulting Engineers and accepted by the International Organisation for Standardisation.

As part of the design process, Concern assesses hazard probability and scale, including hazard history and trends; structural vulnerabilities, including potential failures and impacts; and community capacities, including the opportunities and resources to mitigate hazards. It uses participatory risk assessments to gather some of this information, including the risk history and social dynamics, and complements these with technical assessments carried out by qualified engineers who assess the properties of soils and their geological composition, water flows, erosion patterns, and other features that shape hazard profiles. This, coupled with an assessment of the magnitude of impacts should the structure fail, helps determine the risk profile and the level of risk that the structure should mitigate against.

These three pictures show the importance of hazard proofing structures. The gabions in Afghanistan (right) were constructed by another organisation to control erosion about four years ago. They used the wrong type of rocks, poorly-made mesh wire that corroded easily, and were put in place on a bend in the river exposed to high water flow, meaning that water could erode areas behind gabions. Communities said they received little training and supervision during construction. As a result, the gabions are breaking rapidly. Concern helped this community construct a different barrier downstream (middle), using appropriate construction material (4 mm galvanised wire mesh gabions with non-riverine rocks) and supervising the construction process. The water point in Ethiopia (right) was constructed by Concern and is about a decade old. The point remains functional but its foundation has worn down substantially, the result of improper construction materials (the rocks used for the foundation were too large) and a lack of maintenance (neither users nor the government provide funds for maintenance).

When structures are key to emergency response (e.g. major connecting roads), or when failure might have catastrophic implications (e.g. latrine failures in Haiti could spread cholera), Concern designs structures to be durable over long periods of time as part of a preventative humanitarian strategy. While this ultimately can save lives and resources, it sometimes requires substantial additional upfront funding to the extent that it can more than double the budget in some cases. This is, nonetheless, often seen as necessary – when rebuilding houses in La Gonâve, Haiti, after Hurricane Sandy, it was necessary to build them to withstand horizontal rain, strong winds, floods, storm surges and earthquakes, and to be fire resistant. Factoring these hazards into the house design increased the unit cost, but will save money in the longer term. When failure might not be catastrophic, Concern takes a pragmatic comparative cost-benefit approach to construction, comparing costs of hazard proofing against projected disaster costs to determine its construction approach. In Afghanistan, for example, Concern built a water point that could not withstand high impact earthquakes, as its collapse would not lead to any deaths; in Haiti, on the other hand, it invested in high-cost water points because previous water points had collapsed.

If costs are high and structures are not vital to preserve life, whether because of their occupancy rates or strategic importance, Concern might support the construction of a low cost and disposable structure that can be easily rebuilt after hazard events using locally sourced materials and labour. An example is a wooden jetty in La Gonâve, constructed out of logs driven into the sand. It has not been designed or built to withstand hurricanes, but is easy to replace. Nonetheless, the cost of repairs can be high as compared to costs of hazard proofing: members of one community in Afghanistan, for example, spent weeks rebuilding an irrigation canal every year. Concern intervened to construct a durable take-off point. Similarly, a water point in La Gonâve was destroyed and rebuilt three times following storms. Concern recognised that rebuilding in both cases was costly, so decided to replace these structures with ones designed to last decades with minimal repairs. For residents of Afghanistan this saved months of labour every year reconstructing the canal, and in Haiti it ensured members had long-term access to water. The costs were high—in Haiti double—but it helped ensure that they would withstand storms and flash floods, vital when such hazards were occurring every few years.

The two bridges pictured above - one in Afghanistan (left) and the other in Haiti (right) – were both constructed as part of emergency responses, but have two very different outcomes. The bridge in Afghanistan was constructed with a retaining wall on one side only, while the one in Haiti was constructed with retaining walls on both sides. When it was first constructed, the Afghanistan bridge spanned the entire river, but because retaining walls were not built on both sides of the riverbank, the river was able to change directions and expand, meaning that when floods came the river was impassable by vehicle. Since the bridge in Haiti was constructed with retaining walls on both sides, river change was not a problem and the bridge could be used in any conditions. The bridge in Haiti was constructed by Concern and the one in Afghanistan by another organisation.

Hazard scale is a key design factor. To protect against all potential hazards, Concern designs structures against *peak* rather than *average* hazard, since designing for peak hazards normally also mitigates against all other hazards. It recognises that hazards change and uses trend analysis to try to anticipate those changes, acknowledging that there may still be uncertainties with such analysis.

Designs end up being compromises between elasticity, strength, reparability, and cost. Compromises are inherent in every design element, from choice of material (some materials might have high strength and others greater elasticity) to choice of location (locating a structure in a convenient location that might be more hazard prone or one that is less hazard prone but less convenient). Concern strives to reduce negative trade-offs - a water point in La Gonâve, for example, was constructed with modular components for easy repair at a higher initial but lower maintenance cost.

Proper construction is as important as appropriate design for hazard-proofing structures. Structures might be improperly constructed for a variety of reasons. Sometimes people working on the construction may lack technical knowledge. In these cases, Concern offers training to build technical capacity. Besides improving the quality of the construction, this helps ensure local people are able to repair structures and builds an additional potential livelihood skill set. In other cases, builders may intentionally choose to use poor quality materials or workmanship to cut costs and increase profit, whether by choice or necessity. Establishing a monitoring and oversight system is essential to reduce this risk. In both cases, Concern has found regular visits (which varies based on phase of construction and type of structure) by engineers help to ensure that structures are constructed according to plan - a challenge in mountains when access often is poor

Anticipating change is a key component of design. Flowing water, for example, can cause erosion and other land changes. In Afghanistan (left), Ethiopia (middle), and Haiti (right), erosion has exposed water pipes that were previously buried, increasing the chances of breakage. Concern has worked to reduce the impacts of erosion in a number of ways. In some cases it has shifted pipes away from high erosion areas (e.g. away from riverbeds), decreasing hazard exposure. It has also tried to control erosion, by for example constructing diversion control and/or NRM. Last, it has worked to make the pipes themselves less at risk, by either installing stronger pipes or by making them easier to replace putting them in modular sections.

Check dams, weirs, floodwalls and embankments, and bioengineering

Concern uses check dams, weirs, floodwalls and embankments, and bioengineering interventions to reduce flood, landslide, and erosion risks. Each intervention has its own specific use and techniques. Concern constructs floodwalls and embankments on the banks of rivers to reduce flooding and erosion risks. In Afghanistan, Concern has tested gabions, welded mesh gabions, Hesco cells, masonry walling, and the Big Bag system for floodwalls and found their specific properties conducive to different uses.

Along with appropriate materials, these structures need to be built on a strong soil layer that accounts for the fact that when loadbearing soil gets inundated by water, its loadbearing capacity is dramatically reduced.

Floodwall building material (adapted from Andersson and Dobbin, 2013)					
Type	**Price (m2)**	**Strengths**	**Advantages**	**Disadvantages**	**Durability**
Gabion	$36	Very low to med	• Widely available • Easy to fabricate and assemble on site • Can be filled with river boulders • Has flexibility and 'give'	• Poor quality galvanized wire results in short life • Galvanised coating can wear off in abrasive floodwaters.	• 3mm wire with mesh size 10x15cm very poor • 4mm wire by 8 x 11cm size medium • Good in low wear areas, poor in high.
Weld-mesh gabion	$45	Low- Med	• Easy to transport and handle • Can be installed quickly • Can be filled with a range of boulders between 10-30cm • Has flexibility and 'give'	• Not always available • Steel must be from reliable sources.	• Very good, provided it is correctly installed.
Hesco cell	$36	Med	• Quick and easy to transport and erect • Can be filled with any local material • Easily planted.	• No top or bottom to the basket • 7 x 7cm steel mesh is hot dipped galvanized and uses 3mm wire	• Very good in low wear areas and reasonable in high wear areas.
Masonry Walling	$43	High	• Used in high wear areas to face gabions or Hesco • All products and skilled labour available locally except cement • Comparable to quality gabions in price • Good resistance to abrasion.	• Slow and expensive in relation to other systems • Can crack due to settlement • Frost stops all work.	• Very good provided there is no scouring beneath foundation
Big bag system	$97	TBD	• Easy to transport, erect and fill with any local material except boulders over 150mm	• Sharp material cannot be used as fill • Fill needs to be compacted • May wear through before geo-engineering matures.	• Generally good, but untested in Afghanistan (new product). Two years' use shows positive results.

Erosion is a major problem in Afghanistan and many riverbeds have expanded in width dramatically over the years - some by as much as 40 metres in 40 years. The floodwalls Concern constructs have been used to protect villages from further erosion and, in some cases, to reclaim eroded lands for farming and other activities.

Clockwise from top left: welded mesh gabions, Hesco cells, masonry walling, Big Bag System

Concern constructs check dams in gullies. These reduce flash flood and erosion risks by reducing the water flow gradient, decreasing water velocity, and encouraging deposition of sediments carried in waters. Gully gradient, size, and water volume all influence the spacing, height, and materials of check dams: check dams need to be stronger and more closely spaced together the larger or steeper the gully, or the greater the volume of water that they are seeking to control.

Weirs are similar to check dams in that they decrease water velocity, the main difference being that they are constructed in larger bodies of water such as rivers. As with check dams, weir strength needs to be proportional to dynamic loads caused by hazard exposure and must be strong enough to withstand any predictable and calculated shock load, including water flow and rock fall.

Bioengineering involves planting plants with strong and long root systems (often poplars and willows) to stabilise the soil and reduce erosion. Concern uses bioengineering to reverse small gully growth, strengthen floodwalls and embankments by planting plants behind structures, and replace floodwalls and embankments by planting the Big Bag System with seedlings. Bioengineered structures are designed to increase in strength over time since, as plants mature their root systems connect very deep to rocky layers and reinforce the soil. Additionally, trees can serve as fuel sources. It is essential that the right species be selected for bioengineering, taking special consideration of the rooting structure of the selected plants, their ability to hold soils, and their centre of gravity (plants with high centre of gravity are more likely to uproot in strong winds). Concern is testing bioengineering for Afghan mountain regions and has funds in place in case they fail.

Using bioengineering to reclaim a gully

The temporary shelter (left) and water structure (middle) in Haiti and the floodwall (right) in Afghanistan are all examples of high quality structural measures implemented by Concern. In all cases, these structures were designed based on a solid understanding of the hazard, vulnerability, and capacity context, received regular support visits during construction, and were developed to be easily maintained by users themselves. These examples show that it is possible to build structural measures in mountain contexts that reduce mountain risks.

Lessons to be learned for structural measures in mountain areas

Concern's approach to structural measures in mountain areas shows that the right design and build can minimise risk in a cost effective manner.

Structural interventions such as hazard proofing essential infrastructure is a highly technical activity. **Properly qualified engineers who follow international standards are required** – for designing, monitoring, and supervising interventions. Training both unskilled and skilled workers on engineering projects is vitally important, as is continual site visits by qualified engineers during construction. This will stop basic mistakes, like not constructing retaining walls on bedrock or firm soil, from happening, and help assure the correct materials and techniques for the function and dynamic loads of the structure being constructed. Bioengineering is equally a technical activity, and requires the same degree of knowledge and skill to be implemented correctly.

Concern has developed a draft set of standard operating procedures to guide its staff in implementing engineering projects, which it is in the process of finalising and sharing.

Hazards can be intense in mountain areas, and are likely to become increasingly so with the impacts of climate change. Any structure that is built or hazard-proofed by Concern should be designed **in consideration of the peak intensity of predicted dynamic loads**, or the structure may fail. It is highly likely that structures are exposed to multiple hazards, such as the houses in Haiti that are exposed to floods, fire, horizontal rain, hurricane force winds, storm surges, tsunami and earthquakes. **All hazards should be considered** when designing a structural intervention.

The more important a structure is in terms of the magnitude of impacts should it fail (such as bridges), the more important it is to design for peak intensity, bearing in mind that greater dynamic loads cost more to address. **Structures that are crucial to humanitarian response or that have catastrophic implications if they fail – such as bridges and schools – must be prioritised for improvement.** The determination of the magnitude of impacts should a structure fail should be done at the outset, alongside other technical hazard analyses such as soil and geology characteristics and water and erosion dynamics.

By designing to withstand multiple hazards, and designing to withstand peak intensity for the most important structures has **a cost implication, which donors must be made aware of**. Concern should focus more advocacy efforts on this point if necessary, as the consequences of under-designing structures is damage or collapse, which will certainly result in wasted money and effort, and may have much more significant undesirable consequences.

On-going maintenance must also be considered and made easy (such as short pipe lengths in a water supply scheme); and if maintenance costs are high the structure needs to be made more durable (such as irrigation take-off points in Afghanistan). How maintenance will be done needs to be designed into the intervention, and is context specific. For example, in Afghanistan self-help can work but in Haiti user fees pay for maintenance.

The following general lessons can be learned from the structural measures Concern employs in mountain areas:

- Risk-proofing structural measures requires a proper risk assessment performed by qualified engineers as well as geologists, hydro-geologists, and, when appropriate, seismologists, paying special attention to hazard scale and the dynamic nature of risk.
- Risk-proofing may take substantial upfront investment but can save money over a longer time period.
- Structures that are vital for people in times of emergencies (i.e. hospitals, evacuation centres, and transportation networks) or that would be catastrophic if they collapse (i.e. schools), should be highly engineered to withstand peak hazard and reduce risks of failure.
- When structures are not vital (i.e. have only sporadic occupancy and with no strategic role in emergencies), a comparative cost-benefit approach should be taken to risk-proofing, assessing the cost of hazard proofing against potential ability and costs of repairs.
- Sourcing construction materials may be difficult in mountain areas and should be considered as a maintenance challenge, but to reduce risk external material should still be considered in circumstances where local material is not strong enough.
- Using a mixture of materials to construct floodwalls based on a solid understanding of water flow and erosion patterns can address the potential negative impact of flooding and erosion in a cost effective manner.
- Structural measures and NRM can be used in conjunction to reduce flood and erosion risks, with NRM reducing hazard scale and frequency and floodwalls, check dams, and bioengineering reducing hazard impact.

5. Conclusion: overall lessons to be learned and good practices for DRR in mountain regions

Wherever the context, Concern works to reduce risk as part of its approach to eliminating extreme poverty. This review was a first step in developing general lessons learned about Concern's approach to DRR in mountain areas. Comparing the organisation's work in three different contexts - Haiti, Afghanistan, and Ethiopia - showed that there were similarities in disaster risks and Concern's approach to DRR in each of these contexts. This in turn allowed for generalisations to be made about what might constitute DRR in mountain regions, both in terms of *what* activities to undertake, and *how* to undertake them.

Defining mountains by their geophysical and social characteristics helped to understand the risks and risk reduction practices that might be common to these areas. As areas with steep slopes, poor soils, and social and political marginalisation, the mountains of Haiti, Ethiopia, and Afghanistan had a number of common risks, which Concern tackled through preparedness, NRM, and structural interventions. Nonetheless, while sharing some commonalities, each region had specific risk profiles, with different histories, social modes of organisation, and hazards. Concern's work reflected this; while interventions were generally similar across areas, specific practices and modes of operation varied.

This report indicates that DRR in mountain contexts requires similar practices but that lessons cannot be taken as panacea and must rather be applied following a critical analysis of the unique risk profile of the area. An area might be mountainous in that it has steep slopes and faces landslide and erosion risks, but it might not be mountainous in other dimensions (for example, its isolation, exposure to earthquakes, or its elevation). Indeed, while comparing the mountains of Haiti, Ethiopia, and Afghanistan helps to understand how to reduce disaster risk in 'typical' mountain contexts, it also shows that no mountain context is truly typical.

In assessing DRR in mountain regions, this review allowed for an exploration of how and why risks in mountain areas might differ, and how DRR activities might be adapted to suit these differences. It showed that while risk profiles in mountain areas have some commonalities, the long established general DRR knowledge, concepts, and approaches are not different for DRR in mountain regions. Ultimately, mountain risk is not a natural but is rather a human product, often rooted in lack of assets, unequal power relations, and other forces of inequality. Residents living in all areas had little external support for risk reduction, few assets to use to improve their resilience, and engaged in environmental practices that degraded the environment as coping strategies out of necessity. Practically, this means understanding risk is vital to reducing risk, and reducing risk often requires a multitude of interventions, actors, and stakeholders across sectors. Indeed, the findings suggest the importance of using general DRR tools and approaches to apply to mountain regions.

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

- Mountains often have a common set of hazards (including flash floods, landslides, and earthquakes), vulnerabilities, and capacity profiles.
- Preparedness, natural resource management, and structural measures are common means of addressing the risks arising from such hazards.
- Interventions should be designed in conjunction with each other to ensure that they fully cover the risk. NRM, for example, can be combined with structural measures to reduce erosion and flood risk.

- Mountains can be defined in both technical and social terms. These two perspectives can help in analysing and intervening in different risks.
- While mountainous areas display commonalities, each one is different, meaning that specific mechanisms for reducing risk in mountain areas vary and must be based on a good understanding of the geological and social context.
- Understanding specific risk profiles requires a thorough risk analysis including hazard, vulnerability, and capacity mapping to determine high-risk areas.
- DRR might involve stand-alone activities but should also be integrated into existing programmes.
- DRR interventions – especially engineering – need to be designed for peak hazard rather than average hazard.
- Given the intensity of mountain hazards, interventions need to be properly designed, which requires competent technical staff who are able to provide guidance and constant supervision.
- Hazard-proofing requires investment but can ultimately save resources, which can help the extreme poor escape poverty.
- DRR interventions that protect certain resources often build capitals in the process. Bioengineering, for example, reduces flood risk while also providing a source of fuel.

In spite of the differences that each mountainous area has, the likelihood of active fault lines, steep slopes and friable soils greatly influence the types of hazards common in mountains. The topography is characterised by small catchment areas, lending itself to 'whole of watershed' management approaches, but it is not conducive to large scale early warning systems. DRR must therefore reflect this, and work on smaller scales.

Isolation and access difficulties are also important features of mountain areas that in turn influence the way DRR is approached. Preparedness measures must take access difficulties into account and equip isolated communities themselves to mount emergency responses by pre-positioning stockpiles of response materials, developing local early warning systems, and training communities in response. Similarly, where engineering challenges can be significant because of the topography, monitoring and oversight by engineers is most important. However, this can be difficult to maintain as there are significant cost implications when working in mountains.

In mountainous environments, the extreme ferocity of certain hazards should not be underestimated. This needs to be reflected in DRR, and engineered structures in particular need to be designed for peak rather than average hazard. Furthermore, interventions need to be followed through to completion, often above what organisations are currently doing. Ethiopia is a case in point: in Ethiopia the terraces many organisations are constructing terraces are failing. Concern has found that planting terraces with fodder crops and preventing open grazing results in strong terraces that last. In Haiti, likewise, pipes buried 1.5m underground in a ravine for a water scheme could not withstand the force of run-off water during hurricanes. The scheme has been completely re-designed to take this peak hazard context into account – with the pipes now lifted out of the flood area.

This report shows that none of the challenges posed by mountain regions are insurmountable, but that addressing them requires time, expertise, financial investment, and most importantly, political will. Concern is playing its part in providing solutions, engaged as it is in these regions over the long term, providing access to expertise where it is required, and providing significant investment in disaster risk reduction. Such investment of time, expertise and funding is yielding rich returns in reducing the risks to which resource-poor and vulnerable communities are exposed and contributing to their sustainable development.

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.

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