Incorporating the Local

Bottom-Up Transformation of DRR

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Practical Action
Technology challenging poverty

Contents

Acronyms and Abbreviations

CEWS	Community Early Warning System
CRED	Centre for Research on the Epidemiology of Disasters
CREWS	Climate Risk and Early Warning Systems
DfID	United Kingdom Department for International Development
DPP	Disaster Prevention and Preparedness
DREF	Disaster Relief Emergency Fund
DRM	Disaster Risk Management
DRR	Disaster Risk Reduction
ECHO	European Commission's Humanitarian Aid and Civil Protection Department
EWS	Early Warning Systems
GLOF	Glacier Lake Outburst Floods
GloFAS	Global Flood Awareness System
GFDRR	Global Facility for Disaster Reduction and Recovery
HMG	Her Majesty's Government (UK Government)
Hyogo	UNISDR Hyogo Framework for Action 2005-2015: Building the Resilience of Nations and Communities to Disasters
IASC	Inter-Agency Standing Committee
IFRC	International Federation of Red Cross and Red Crescent Societies
INGO	International Non-Governmental Organization
NGO	Non-Governmental Organisation
NRCS	Nepal Red Cross Society
OECD DAC	Organisation for Economic Co-operation and Development - Development Assistance Committee
Paris Agreement	UNFCCC Paris Agreement on Climate Change Beyond 2020
S&T	Science and Technology
SDGs	UN Sustainable Development Goals 2015-2030
Sendai	UNISDR Sendai Framework for Disaster Risk Reduction 2015-2030
STAG	UNISDR Science and Technology Advisory Group
UNESCAP	United Nations Economic and Social Commission for Asia and the Pacific
UNFCCC	United Nations Framework Convention on Climate Change

UNISDR	United Nations Office for Disaster Risk Reduction
VCA	Vulnerability and Capacity Assessment
WMO	World Meteorological Organization
Yokohama	UNISDR Yokohama Strategy and Plan of Action for a Safer World

Definitions

Disaster Risk Management (DRM): The implementation of DRR policies, processes and actions to prevent new risk, reduce existing disaster risk and manage residual risk contributing to the strengthening of resilience (UNISDR 2015).

Disaster Risk Reduction (DRR): Preventing new and reducing existing disaster risk and managing residual risk to contribute to resilience (UNISDR 2015).

Early Warning System (EWS): A process of risk assessment, hazard warning, communication and preparedness activities that enable individuals, communities, businesses and others to take timely action to reduce risk (UNISDR 2015).

Hard and soft technologies: *Hard technologies* are the tools, machines, devices and equipment that are the physical embodiment of technology, and/or technological process based on engineering techniques and principles: 'know-how.' *Soft technologies* are the 'scaffolding' for individual and collective self-determination, and include support systems, group process techniques, design methodologies, decision making processes: 'know-why,' 'know-what-for,' and 'care-why' (Laszlo 2003).

High and low technologies: *High tech* are sophisticated technologies which require complex infrastructure, technical expertise to construct and/or to use, and are often costly to obtain and to operate. *Low-Tech* are small-scale technologies which do not require complex infrastructure, are relatively simple to use, cost little to construct or obtain and next to nothing to operate (Laszlo 2003).

Land-use planning: The process undertaken by public authorities to identify, evaluate and decide on different options for the use of land, including consideration of long term economic, social and environmental objectives and the implications for different communities and interest groups, and the subsequent formulation and promulgation of plans that describe the permitted or acceptable uses (UNISDR 2009).

Mitigation: The lessening or minimizing of the adverse impacts of a hazardous event (UNISDR 2009).

Preparedness: The knowledge and capacities developed by governments, response and recovery organizations, communities and individuals to effectively anticipate, respond to and recover from the impacts of likely, imminent or current disasters (UNISDR 2009).

Prevention: Activities and measures to avoid existing and new disaster risks (UNISDR 2009).

Resilience: The ability of a system, community or society exposed to hazards to resist, absorb, accommodate to and recover from the effects of a hazard in a timely and efficient manner, including through the preservation and restoration of its essential basic structures and functions (UNISDR 2009).

Risk communication: Both a one-way transfer of hazard and risk related information and their management, and as a two-way exchange of related information, knowledge, attitudes and/or values (Höppner and Buchecker 2010).

Structural and non-structural measures: *Structural measures* are any physical construction to reduce or avoid possible impacts of hazards, or the application of engineering techniques or technology to achieve hazard resistance and resilience in structures or systems. *Non-structural measures* are measures not involving physical construction which use knowledge, practice or agreement to reduce disaster risks and impacts, in particular through policies and laws, public awareness raising, training and education (UNISDR 2009).

Technology justice: An approach to the development and use of technology that allows people to choose and use technology to improve their lives; focuses research and innovation to meet humanity's basic needs and protect the planet; and makes sure technologies don't harm others, now or in the future (Practical Action 2016).

Vulnerability: The conditions determined by physical, social, economic and environmental factors or processes which increase the susceptibility of an individual, a community, assets or systems to the impacts of hazards (UNISDR 2009).

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Executive Summary

Disasters affect millions of people every year. Globally, they disproportionately impact the world's most vulnerable, causing the forced displacement of populations and undermining advancements in poverty reduction and human development. Floods accounted for 43% of all recorded events in the last 20 years (UNISDR & CRED 2015). As construction along floodplains expands, levels of environmental degradation rise and anthropogenic climate change alters already delicate ecosystems, future flooding risks are expected to increase. Recent policy advances have made significant progress towards mainstreaming the anticipation and reduction of these risks. As policy has developed so too has the potential for technology to contribute to the process of disaster risk reduction (DRR). Perhaps most importantly, enhanced Early Warning Systems (EWS) allow for increasing accuracy in disaster prediction. Despite technologic advances and the enhanced emphasis of DRR policies, it is apparent that the intended benefits of these efforts remain unequally distributed across international, national and local divides. Addressing this inequity is rightfully a priority of UK-based INGO Practical Action.

This report aims to support Practical Action's work in the development, implementation and roll-out of technologies capable of increasing a community's resilience to natural hazards. For this study, we focus on flooding EWS as representative of the most significant challenges in the implementation of DRR technology. Through an analysis of EWS policies at the national, district and local levels in the UK, Peru, and Nepal, the report identifies common and distinct challenges to meeting the needs of the most vulnerable in "technology-rich" and "technology-poor" countries. Our analysis offers an assessment of different approaches to understanding disaster risk and the extent to which these approaches inform, and rely upon, different approaches to forecasting and risk communication. This case study analysis allows us to effectively identify the key determinants of success throughout the EWS process. This insight provides a basis to assess the efficacy of existing international frameworks, incentives and discourse to leverage the change required. By recognizing the strengths and limitations of existing approaches at the local, national and global level, the report extrapolates wider recommendations to shift DRR approaches.

A focus on the extent to which DRR technology meets the needs of the most-vulnerable directs our attention towards the local level. We assert that when systems fail to capture the complex nature of disaster risk, they ultimately contribute to incomplete and inadequate DRR and fail to meet the needs of their intended beneficiaries. Efforts to assess and communicate disaster risk can only reduce impact by acknowledging the interaction between exposure, natural hazards and multidimensional socioeconomic vulnerabilities. In order to fulfil their potential, DRR technologies must similarly reflect a contextual understanding of local needs, and can greatly benefit from a bottom-up engagement from the outset. Given the extent to which national political and institutional dynamics often fail to deliver accountability and incentive mechanisms to encourage this approach, our analysis also considers the extent to which current international frameworks can shift behaviour.

Having identified the barriers to the successful development of EWS, we assess the extent to which global frameworks are fit for purpose. The Sendai Framework is the primary site of our analyses given that it recognises the need for bespoke strategies to address "the local", in terms of specific vulnerabilities, capabilities, and knowledge of risks. However, when operationalized, we find that there are few mechanisms in place to include local actors to the necessary extent identified above. We note that a top-down approach to DRR often persists and that the implementation of "technological solutions" continues to reflect a lack of recognition of these barriers to success. Whilst innovative technologies, methodologies and approaches to DRR are being implemented and funded by NGOs and other agencies at the local level, global frameworks principally envision the transfer of technology and knowledge at the national level. Although current global frameworks represent a useful "blueprint", countries struggle with implementing structures and incentive schemes that improve efficiency and effectiveness throughout the disaster management cycle.

An additional challenge emerges when we recognise the failure to address the root-causes of vulnerability to natural hazards. Despite a significant global shift towards promoting resilience to minimize hazard impacts, competing narratives and incoherence between international frameworks prohibit the systematic and radical approach that is required. This report argues that the true potential for DRR technology can only be realised if contextualised within a need for "transformational resilience". Given the political challenges to progressing this agenda at a national and international level, it asserts that lessons learned in the employment of EWS can provide a basis to build support for this agenda.

This report proposes a number of actionable recommendations to understand, engage and embed local needs, knowledge and views across EWS. It argues that the persistence of top-down approaches can be disrupted if actors involved in international frameworks, national governments and NGOs recognise the benefits to implementing these feasible adjustments to existing EWS processes. Longer term, we also identify a number of recommendations to ensure that local experiences become the benchmark for success across DRR policies and practices. Ultimately, we argue that it is only by striving towards "transformational resilience" that DRR can fulfil its potential. Given the increasing complexity and severity of disaster risk, the costs of not doing so are too high. It is only by incorporating the local and building from the bottom-up that governments and societies can develop appropriate solutions that address the needs of the most vulnerable, and ultimately save lives.

1. Introduction

Flooding is the leading cause of disaster casualties (Doocy et al. 2013). According to Christian Aid, over a billion people worldwide will be at risk of catastrophic flooding in 2016 (BBC 2016). Effective disaster risk management and reduction strategies (DRM/R) offer opportunities to address flooding and other climate-related risks and to contribute to sustainable development (Mysiak et al. 2015). According to the OECD, in addition to contributing to the frequency, magnitude and unpredictability of natural hazards, the rise in anthropogenic climate change poses a serious risk to poverty reduction (2003). Increased investments in DRR reflect the progress of global agendas designed to enhance resilience and the potential for technology to contribute to this agenda has been widely acknowledged (Clark 2012).

At a foundational level, accurate forecasting of severe weather events allows for earlier planning and improved preparatory actions and coordination, which can reduce the humanitarian and economic impact of hazards (Alfieri et al. 2013). Beyond this role in predicting imminent hazards, Science and Technology (S&T) can support all phases of the disaster management cycle, including: prevention, warning, response and recovery. Whilst technology is rightfully situated "at the heart of human development", we must recognise that "access to technology and its benefits are not fairly shared" (Meikle 2016, 8). In the face of increasing climate risks, addressing this inequity should be a key priority.

This report is designed to support Practical Action's work in this space. First, it acknowledges that technology for risk reduction involves an interplay between different actors, at all levels of governance with distinct incentives and accountability mechanisms, and that coherent methods of measuring progress have the potential to align all actors operating in this landscape. Second, it argues that DRR must acknowledge root causes of vulnerability and power relations and recognises these challenges as integral aspects of "transformational resilience." Efforts to achieve "technology justice" - to address the inequity in global DRR technology and meet the needs of the most vulnerable - can be enhanced by recognising this context and involving the local in all stages of the development, implementation and roll-out of technology DRR.

1.1 Objective

The aim of this study is to identify the barriers to ensuring technology enables DRR to contribute to transformational resilience. The study will focus on the use of flooding Early Warning Systems (EWS) as representative of wider S&T that operates across the hazard risk cycle at a local, regional and international level. It will seek to identify short and long term recommendations to address gaps in national and international DRR policies in order to ensure they address the needs of the intended beneficiaries of DRR technology[1].

1.2 Scope and Methodology

To extrapolate lessons learned in the design, distribution and use of technology for DRR, this study focuses on the employment of EWSs to reduce the impact of disasters. Whilst "best practice" suggests that EWS should be multi-hazard and multi-level (Sendai 2015), these systems are still being designed and developed, which limits comparability amongst countries. This study will focus on existing EWS designed to address flooding risks - understanding the current limitations of these systems offers an opportunity to inform approaches to multi-hazard EWSs in the future.

Methodology

This study incorporates DRR efforts in Nepal, Peru and the United Kingdom (UK). All three countries have regions that are highly prone to flooding, and position disaster management as a high priority. The report is based on qualitative research. It was informed by an extensive review of literature and current debates surrounding vulnerability, DRR, EWS and resilience; an analysis of primary data, including normative

[1] See ANNEX A for Terms of Reference.

frameworks, risk assessments and methodologies, country reports, and government databases; and interviews with in-country experts. We interviewed Practical Action and national Red Cross organizations' staff within the UK, Nepal and Peru, as well as policymakers and academics[2]. Practical Action's presence in these countries facilitated access to key stakeholders. We examined the efficacy of such policies by exploring the reported vulnerability and capabilities of rural populations in high-risk flood zones by comparing both country disaster management plans, legislation and NGO reports of needs-assessments.

To support our analysis, we first mapped the structure of DRR and EWS across our case studies. We then identified the actors involved at each level of governance (from the international to the community levels), and their roles and responsibilities in each phase of the disaster management cycle. Finally, we identified strengths and barriers to effective EWS in each case study, using global frameworks as our baseline. Ultimately, we determined that the most effective analysis would involve an in-depth study comparing the reported development of international or national DRR initiatives to community experiences of resilience.

Limitations

Due to limitations of time and resources, this study prioritised academic theory and secondary reports. Technological issues with several of our interviews to Bolivia, Nepal and Peru may have led to an inconsistent representation of involved actors across regions. Whilst our research was principally influenced by Practical Action, we recognise that further research would benefit from engaging with a broader range of NGOs working to support DRR technology. Similarly, research into a wider selection of DRR technologies is required to address the disconnect with local needs and vulnerabilities.

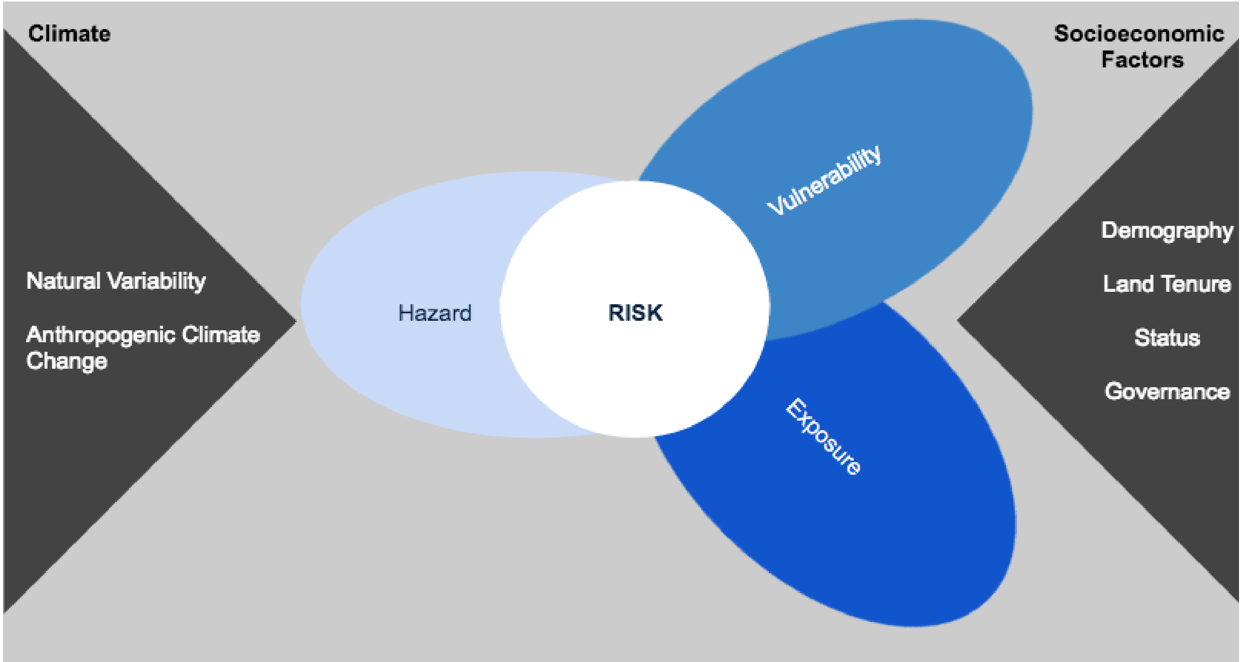
2. Conceptual Framework

2.1 Disaster Risk

It is essential to establish a base understanding of disaster risk in order to assess potential contribution of DRR technology. Disasters aren't simply caused by external shocks, but result from a complex interaction of hazards, vulnerabilities and exposure (UNISDR 2009). In the case of flooding risk, whilst weather events represent a *natural* hazard that acts as a key determinant of the risk of flooding, socioeconomic factors also play a key role in determining the nature of flooding risk. The below graph represents the relationship between these domains and identifies critical determining factors of the characteristic and magnitude of each hazard, vulnerability and exposure.

[2] See ANNEX B.

Figure 1: Illustration of Disaster Risk



Source: Adapted from IPCC 2014 and Rufat et al. 2015.

The factors listed above are not exhaustive, but represent some of the key determinants of flooding risk. Whilst there exist "a multitude of possible approaches to risk assessment and risk modelling" (GFDRR 2014, 6), we draw attention on the role of climate variables in determining flooding risk and the complex interaction between social dynamics that influence individual and community vulnerability. Rufat et al. provide an invaluable overview of emerging vulnerability indices that capture the breadth of this latter dynamic[3].

2.2 Transformational Resilience

It is generally agreed that resilience can reduce the impact of hazards, and that it is an attribute of sustainable development in the face of anthropogenic climate change (UN 2016). However, there is ambiguity surrounding the term given its application within distinct contexts. This section will review the debate surrounding resilience-building strategies to establish an understanding that can facilitate a systematic approach to DRR.

The positioning of DRR and resilience on a global stage has occurred in conjunction with a shift in mentality from response towards disaster prevention and preparedness (DPP). Aside from an increased focus on resilience within development policy and practice, this shift has also been facilitated by studies supporting the value-for-dollar of investing in community capabilities to mitigate and adapt to climate change rather than in disaster response and reconstruction (Venton, Coulter, et. al 2013). International funding streams and the Paris Agreement reaffirmed this approach, yet there is still no real clarity on what delineates climate change adaptation, prevention, resilience and DRR and the ways they are interlinked[4]. Resilience, furthermore, is mentioned in all the 2015 frameworks, yet it is used within different contexts and with

[3] See ANNEX C.

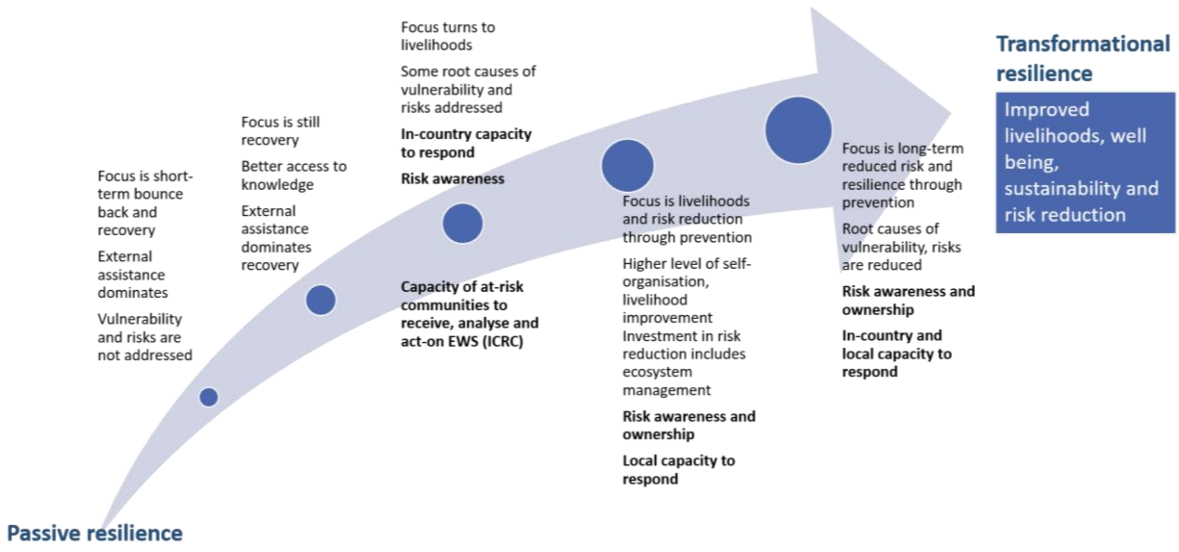
[4] Between 2010-14 the total amount of official humanitarian assistance reported as DPP by all donors reporting to OECD DAC Creditor Reporting System increased from USD 506 million to USD 981 million. (GHA 2016).

varied meanings[5]. The contestation surrounding resilience also emanates from the fact that international organizations and the international development system are increasingly applying this term within distinct contexts from community resilience to hazard impacts, to individual psychosocial resilience to shocks (such as war and conflict) (Becker et al. 2015). For this reason, the operationalization of resilience has been difficult. As best stated by Klein et al. (2003), "after thirty years of academic analysis and debate, the definition of resilience has become so broad as to render it almost meaningless."

In DRR, resilience generally refers to the capacity of a system to absorb shock or change and maintain its core function (Nguyen and James 2013). The idea of "bouncing-back" from disasters is problematic given the context of anthropogenic climate change and the increasing occurrence and magnitude of hazards. In a literal sense, it would return communities back to the same vulnerabilities that facilitated the extent of the hazard's impact. The concepts of "building back better" and "bouncing forward," therefore, were introduced as ways of reducing both vulnerabilities and exposure to hazards in the 'recovery and reconstruction' phase of the disaster management cycle (Sudmeier-Rieux 2014). As proposed by Sudmeier-Rieux (2014), for resilience to offer a systematic approach to DRR, it needs to be "assessed critically as one attribute of sustainable development" (75). As such, she proposes emphasizing the value of using *transformational resilience* to address underlying vulnerabilities and power relations.

The following figure 2 builds on Sudmeier-Rieux's understanding of the elements that lead to a path of transformational resilience. In this study, we acknowledge that countries are situated on different points along this curve. They are inevitably limited by resources and capacities at all levels of governance. However, given an increasingly complex risk outlook, incorporating a strategy of transformational resilience in DRR and DRM policy is essential to development in an age of climate change. In our following analysis of the extent to which technology can be used appropriately to attend local needs, resilience will be used in the context of its transformational capacity.

Figure 2: The Path to Transformational Resilience



Source: Adapted from Sudemeier-Rieux's model of transformational resilience obtained from Hostettler 2016.

[5] The UN Sustainable Development Goals 2015-2030; the UNFCCC Paris Agreement on Climate Change Beyond 2020; and the UNISDR Sendai Framework for Disaster Risk Reduction 2015-2030, which replaces the Hyogo Framework for Action 2005-2015.

2.3 Sendai Framework for DRR

The Sendai Framework, adopted by 187 countries at the March 2015 UN World Conference, is illustrative of the progress and limitations of current DRR policy. The overarching goal of the Sendai Framework is to "prevent new and reduce existing disaster risk through the implementation of integrated and inclusive economic, structural, legal, social, health, cultural, educational, environmental, technological, political and institutional measures that prevent and reduce hazard exposure and vulnerability to disaster, increase preparedness for response and recovery, and thus strengthen resilience" (Sendai 2015).

Sendai established seven targets and four priorities against which progress should be monitored[6]. Building on the Hyogo Framework, the targets measure progress in DRR through global (rather than local) achievements. Indicators were developed by the OIEWG, and adopted through a UN resolution in February 2017 (McClean 2017). However, Sendai largely limits national implementation of DRR strategies until 2020 to developing the capacity to collect statistical data for the effective measuring and monitoring of regional progress. Whilst this report recognises the need to build capacity to ensure UN member states can meet reporting obligations, it suggests that these targets offer limited opportunities to deliver the framework's "people-centred", multi-sectoral and multi-levelled processes. The Sendai Framework provides an invaluable impetus to improve EWS processes; however, the ability of reporting mechanisms to encourage substantive changes, remains to be seen.

2.4 Science and Technology for DRR

In acknowledging the value of technology to support DRR within a wider transformational resilience agenda, it is important to note how cultural, political and social structures shape technologies. Technology is embedded with political and social structures; therefore, it ultimately reflects certain values and beliefs (Laszlo 2003). In the global frameworks, S&T is considered to support and enhance resilience and DRR. Although the frameworks generally acknowledge the value of locally sensitive perspectives, S&T is ultimately valued in its potential to develop *global* "best practices".

The UNISDR recognizes the need for both structural and non-structural measures to reduce hazard risk. This distinction, however, fails to acknowledge the cultural element behind S&T. In this sense, unequal access to technology will translate into unequal benefits, and can even lead to an increased vulnerability of marginalised individuals. Laszlo (2003) distinguishes between high and low technology based on the degree of sophistication and accessibility, and between hard and soft technology based on their physical or social attributes. Soft technologies (which differ from non-structural measures) are the "'scaffolding' for individual and collective self-determination" (Laszlo 2003). The success of both hard and soft technology, is dependent on the extent to which it aligns with local culture and understandings. Technology justice, therefore, not only implies greater access to technology but also the availability of *appropriate* technology.

Local Processes

Local mechanisms to cope with hazards have evolved and been implemented overtime according to local conceptions of risk. Bottom-up and horizontal development and application of technology is generally more successful than top-down technology development, even when these are 'adapted' to local contexts (EPFL 2016). Despite the success of such holistic developments, local capabilities are frequently overlooked or undermined by national and international to DRR processes. Indeed, the diminished value of local perspectives is reflected in much of the language surrounding technology development (Shaw et. al 2016, 6).

International and Regional Processes

Global frameworks now acknowledge that anthropogenic climate change is a key driver of disaster risk and that severe weather events are increasing in frequency and intensity (Mysiak et al. 2015). Following the 2015 frameworks, distinct platforms increasingly focus on both funding and facilitating the transfer of DRR knowledge and technology amongst countries. Sendai, for instance, relies on a regional and network

[6] See ANNEX D.

process, under the coordination of the UNISDR Scientific and Technical Advisory Group (STAG). In January 2016, the 'Science and Technology Roadmap to Support the Implementation of the Sendai Framework for Disaster Risk Reduction 2015-2030' ("S&T Roadmap") was approved. It delimited expected outcomes, actions, and deliverables under each of the four priority of actions of the Sendai Framework (UNISDR 2016).

Meanwhile, regional platforms have advanced action plans since the adoption of Sendai[7]. The Asian Ministerial Conferences on Disaster Risk Reduction (AMCDRR), for example, published a status report to understand the advancement of science and technology in DRR in 11 countries in Asia. The report incorporates a methodology proposed by Shaw et al. (2016) and identifies opportunities for the S&T community to support Sendai whilst noting the importance of complementing hard and soft technologies. ASTAAG's efforts to advance the incorporation and assessment of S&T within Sendai reflect the usefulness of regional platforms, and will become a likely reference for other regional platforms to advance DRR.

3. Mind the Gap: Analysing the flood EWS process

EWS are a central component to development and DRR practices. Despite their recognized value, over 80% of the world's 48 least developed countries are limited to basic EWS (WMO 2016). EWS have four components: risk knowledge, monitoring, warning communication, and response capability (ICRC 2012)[8]. Effective EWS should provide timely warnings of impending hazard events to both institutions and communities, reducing impact on lives and critical assets (UNESCAP 2015). As indicated by UNESCAP and RIMES (2016) flood risk information should provide "information on location, onset, magnitude, extent, and duration of potential flooding and its likely impacts, and delivered with adequate lead time." Furthermore, "best practice" dictates that EWS need to be people-centred and end-to-end, which exacts coordination and collaboration amongst different administrative levels[9] through all four components.

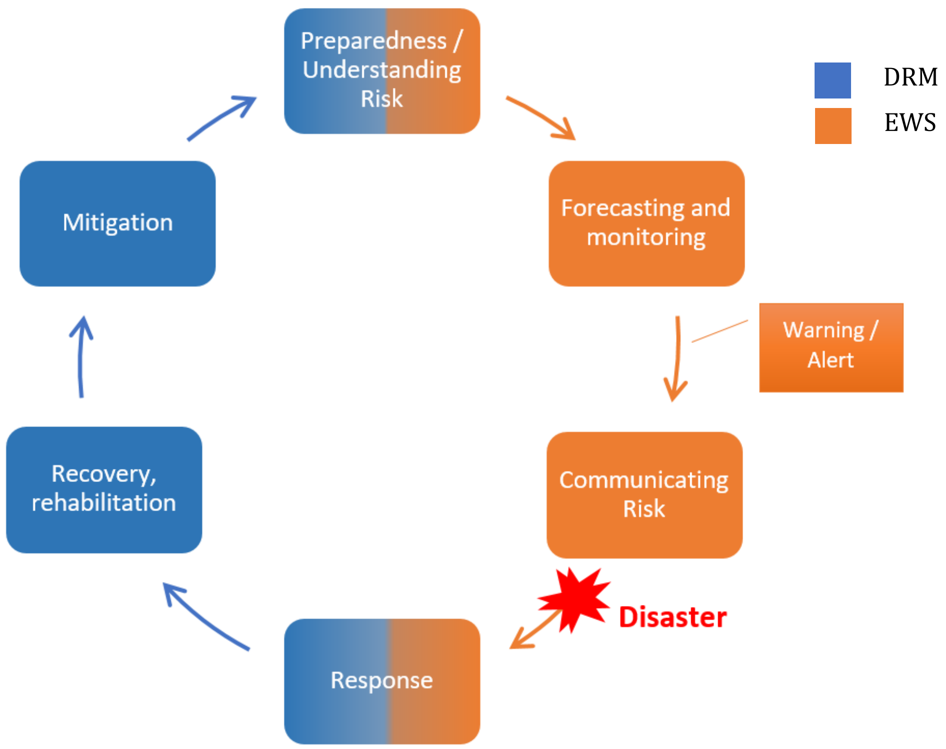
[7] Regional platforms are 'multi-stakeholder forums' coordinated by UNISDR regional offices to improve coordination and implementation of DRR activities while linking to international and national efforts

[8] These systems can be used for small-scale and large-scale, sudden and slow-onset hazards.

[9] See ANNEX E for a diagram on ICRC EWS roles.

The below diagram represents our understanding of the EWS process situated within the wider disaster management cycle.

Figure 3: EWS Process Within the Disaster Management Cycle



Source: Adapted from the Disaster Management Cycle and EWS components, ICRC 2012 and UNISDR 2006.

The following sections will offer a micro analysis of the constituent elements of flood EWSs implemented in Peru, Nepal and the UK. By understanding the strengths and weaknesses of different processes and the barriers and opportunities for change, the study will help to inform DRR policy recommendations at the national and international level.

3.1 Overview of country disaster risk profiles

Nepal, Peru and the UK are at risk of flooding given their geographic locations and exposure to extreme weather events. Despite the prioritization of DRR in national risk assessments of flooding, each has developed varied levels of effective preparedness and response to hazards. A key determining factor of this variance is the disparity between tech-rich and tech-poor infrastructures of each case-study, and between in-country capacity to prepare, mitigate and respond to disasters[10]. The extent to which hazards impact land and livelihoods of individuals is dependent on the capacity of stakeholders to assess the vulnerability and implement effective technology and preparedness measures given social, economic and technological capabilities. As will be argued, access to, ownership and use of technology greatly impacts vulnerability and exposure to disasters. Furthermore, the operationalization of DRR policy structures different actors' activities and incentives and reflects to what extent the local is involved in national decision-making and

[10] See ANNEX F for a basic risk profile and list of actors involved.

planning. The following sections will map the barriers in implementing appropriate technology throughout the EWS process.

3.2 Operationalization of DRR policy

MAIN BARRIERS

- Lack of policy coordination and collaboration between actors at all administrative levels
- DRR policy is disconnected from local processes and needs
- Top-down DRR funding processes result in misaligned incentives and accountability mechanisms

The Sendai Framework acknowledges that states have primary responsibility to prepare for and respond to disasters in their own territories. Many of the advances obtained in the last decade relate to an increasing incorporation of DRM into national legal frameworks. This has corresponded with the creation of government agencies and the allocation of roles and responsibilities from the national to the local governments. Response to disasters, overall, has improved with the implementation of new technology, improved monitoring, and increased access to information. However, numerous actors populate the DRR landscape, and lack of coordination and collaboration amongst these actors both limits action and can even undermine efforts to innovate and improve DRR processes.

Limitations to Operationalizing Frameworks

It is important to recognise the limitations of international frameworks in the operationalization of DRR policy, given their influence in policy changes, best practices and international and regional collaboration. Indicators developed for target G of Sendai, which refers to EWS, are insufficient in ensuring that EWSs are truly “people-centred[11].” Assessing progress by quantifying the number of people covered by EWSs and the existence of national and local risk assessments, does little to supply sufficient guidance to ensure that these risk assessments capture the complexity of vulnerabilities, even if these assessments "are *understandable* for stakeholders and people" (Sendai Expert Group 2015). Additional assessment on the needs of beneficiary populations is essential in the development of "people-centred" EWSs. The involvement of local populations, *as active contributors to this process, rather than passive recipients*, is essential to ensure EWSs are capable of instigating appropriate response to impending disasters

The UNISDR Asia Pacific Office and the Asia Science Technology and Academia Advisory Group (ASTAAG) has made significant progress to assess the link between S&T and DRR in the context of Sendai. Although it offers a useful and systematic way to assess the use of S&T in national risk governance frameworks (Shaw et. al 2016), it is also limited in its incorporation of the local. Specifically, it determines the role of S&T in “validating” indigenous knowledge, yet overlooks local capacity to *generate knowledge and contribute to the development of technology.* This language inherently discredits local understandings of risk, framing its existence as lacking official recognition or validation in the world of DRR. As mentioned above, technology must be *valued* by at-risk communities to elicit an appropriate response.

The operationalization of international framework financing is additionally relevant to EWS capacity building in developing countries. Bilateral and multilateral agreements have been historically useful to improve standards, policies, and legal frameworks. Peru’s current DRM framework is an example of this. Its 2014 National Plan for Disaster Risk Management 2014-2021 (PLANAGERD) was developed with the support of ECHO and the DIPECHO Programme in Latin America and the Caribbean and of ECHO local partners (PCM 2015). Whilst the Plan is a significant achievement, it is closely aligned with international commitments, and encourages accountability to donors. As such, it discourages *bottom-up accountability*, i.e. responsiveness to local governments and at-risk populations. In financing DRR programmes,

[11] See ANNEX D.

quantifiable tasks are often prioritised (Tong 2004). Such top-down processes imply a preference for objective indicators and inherently exclude beneficiary experiences of disaster in the development of new technologies. This ultimately limits the effectiveness of DRR technologies in enhancing local capacities (Gostelow 1999).

3.3 Understanding Risk

MAIN BARRIERS

- Limited resources and capabilities to assess the social and human aspects of vulnerability
- Misconception of level of risk may increase vulnerability
- National EWS programmes lack local awareness and ownership and, therefore, have little influence on the perception of risk at the community-level.

The development of a local or national disaster risk profile is the first step in developing a successful DRR strategy. As previously mentioned, risk to hazards is based on a combination of exposure, hazard and vulnerability. In our analysis, we noticed an emphasis by government entities on hazard and exposure in existing risk assessments in-part due to perceived difficulties in quantifying subjective risk perception, and consequently, vulnerability. Risk analysis informs risk mitigation and disaster response strategies. Therefore, where initial variance between individual and (inter)national perceptions of risk exist, it will affect future DRR decision making (Kasper 1980). Such differences inevitably contribute to an accumulated divergence in the application of preparedness and response tools. Similarly, technology that fails to meet the needs of local communities can affect local decision making and ultimately contribute to, not limit, local exposure to risk. Central to vulnerability, is how individuals perceive their own risk and how they choose their response based on their interpretations (Eiser et. al 2012). This section will analyse both government processes to understanding risk, and local understanding and awareness of risk.

Government Processes of Understanding Risk

Risk assessments in UK, Nepal and Peru are distributed between agencies at the national, district and local levels[12]. For example, in the UK a five-year National Risk Assessment (NRA) provides the primary mechanism for capturing all hazards and risks and Lead Government Departments (LGDs) have responsibility for addressing risks that fall under their relevant policy purviews. As the LGD for flooding risk, the UK Environment Agency (EA) provides a comprehensive flood risk assessment that informs this national picture. It is important to note that in the UK, decision-making does not always reflect this understanding of risk. For example, risk assessments, and post-flood reviews, do not always inform land-use planning (McClenaghan 2016). Additionally, individuals in flood-prone areas are not always willing to relocate, despite being aware of risk.

Access to flood insurance also influences individual decision-making via risk transference (Government Office for Science 2012, 74). The transference of risk does not render the population exempt from experiencing flooding but it does reduce exposure to, and the financial impact of, flooding. Unlike in the UK, at-risk populations in Nepal and Peru face increased risk to flooding. Their vulnerability is compounded by poverty and the absence of viable land and livelihood alternatives. These populations are limited in their ability to transfer risk effectively, forcing them to accept risk while compounding their vulnerability through increased poverty.

In developing countries, such as Peru and Nepal, risk assessment roles are frequently distributed among different agencies and levels of governments. In the case of Peru, regional and local governments are the main authorities for executing DRR processes, and are required to provide technical and scientific information on hazards, vulnerabilities and risks in the National System of Risk Management (Art. 14 of

[12] See ANNEX F for basic risk profile and actors involved.

Law 29664). Nevertheless, in practice, regional and local governments do not have the budgets to carry out these risks assessments creating a gap in risk knowledge. High-level risks assessments tend to be conducted by national government entities and rarely capture the complexity of vulnerabilities. In the case of Peru, risk assessments are generally hazard-specific and are conducted by the relevant agency.

In line with Sendai Framework recommendations, and the potential of technology to improve risk assessments at all levels of government, Shaw, Izumi, and Shi (2016) identified key activities where the S&T community can engage to support the understanding of disaster risk at all levels. Activities include data generation and management; hazard, risk and vulnerability maps; GIS data bases; good practices, training and education, all of which are relevant for the implementation of EWS.

Local Understanding and Awareness of Risk

The importance in understanding local capability and vulnerability to improve resilience is generally undisputed. Sendai (2015) acknowledges the need for an "inclusive risk-informed decision-making" based on disaggregated data complemented by traditional knowledge. Capability to do so varies drastically by state, region and community yet we identified that awareness of risk and vulnerability at the local level determines the effectiveness of EWS. Awareness of risk, furthermore, has significant implications for other phases of the EWS process.

A main challenge to understanding vulnerability and resilience is measurement. In many developing countries, NGOs are leading the implementation of innovative methodologies for risk assessments, particularly in rural communities. It is important to realize that these assessments have limited influence on decision-making prior to and after a disaster if there is limited cooperation and information-sharing with government agencies. In Nepal, these linkages with local governments are being made. Practical Action and the NRCS work together to organize vulnerable people into task forces or Community Disaster Management Committees (CDMCs). These interventions are aligned with VCAs, which are centred on community task forces and collaborate with government and non-governmental agencies to expand the effective implementation of EWS and hazard response plans. CMCS templates analyse the availability, access and linkages of services and facilities needed at the time of disaster from the government and security agencies, local Red Cross Society, organizations and NGOs, as well as financial institutions, cooperatives and public health centres. Such system analysis highlights organizational response capabilities, enhancing information sharing capacities and limits variance in approaches to risk assessment, thereby discouraging future divergence in priorities and response (NRCS 2011). The additional emphasis on involving of a variety of actors and technologies *before* the disaster encourages the successful dissemination of information and response to EWS. Ultimately, multi-levelled participation in risk assessment improves risk awareness, and builds trust between all actors involved.

Per Rufal et al. (2015), risk perception is influenced by awareness, prior experience, knowledge of flood protection measures, risk denial or acceptance, and trust in officials[13]. The government of the United Kingdom (HMG) recently acknowledged the relationship between risk awareness and vulnerability. A recent study conducted by HMG concluded that low individual awareness of flood risk contributed to vulnerability of "older people, 'new' residents, those in lower socioeconomic groups, parents with young children, disabled people and mobile home dwellers" (EA 2005, 5). Across all three case studies, young families, or families with a female or elderly head of household, were noted to be at increased risk. In Nepal, analysis on the impacts and preparedness of communities along the distinct river basins is essential for identifying vulnerabilities in the traditionally hierarchical society. Throughout the Himalayan region poverty exists "extensively based on the rural–urban, geographical, gender, and caste/ethnic divisions" (CBS 2005, Murshed and Gates 2005, Boyd and Lindsey 2011). As such, vulnerability increases for these populations in the immediate and long-term post-crises setting.

[13] See ANNEX C.

3.4 Forecasting

MAIN BARRIERS:

- High technology is required for geographic specificity and long-term forecasting
- Impact based forecasting relies on a wider informational base and new methodologies

Forecasting is the technological core of international, national and local EWSs. It is central to the ability to provide communities with anticipation of impending hazards with the aim of mitigating their impact (Alfieri et al. 2013). These technologies can vary from a simple unit of measurement in a body of water, or they can be as advanced as satellite meteorological systems that are cross-referenced over decades of flood data to ensure maximum accuracy. When employing a model, UNESCAP stress that the complexity of the system is only as effective as the infrastructure permits (2016).

Satellite Meteorological Systems

The UK is a leading partner in global innovations in forecasting and monitoring of both geomorphological and hydro-meteorological hazards[14]. Furthermore, the UK harnesses its hard-technological capacity to compare over 100 years of historical data, applying an innovative use of "synthetic" data based on known conditions and alternative outcomes of previous extreme weather events (Met Office 2017a). Following the Pitt Review of the 2007 UK Summer Floods, HMG recognised the need to improve the geographical specificity of the hydrological forecasting model. The development of a "Grid-to-Grid model" (configured to a 1km2 grid) provides more opportunities for targeted river flood warnings by taking better account of the "location and intensity of rainfall forecast, by high-resolution weather models" (Collier 2016, 220). The benefit of this technological innovation is evidenced by the fact that this new model increased the national flood forecasting horizon from two to five days (Collier 2016).

Flood detection techniques have improved at a global scale through the development of ensemble flood forecasting and EWS like the Global Flood Awareness System (GloFAS). Whilst this is indicative of future potential for developing countries (Alfieri et al. 2013), much forecasting capacity is still dependent on national hard technology capabilities. However, bilateral and multilateral processes to the transfer of technology are improving. For example, in July 2014, Peruvian government agencies signed a bilateral agreement with the Pacific Disaster Center (PDC) to support 'research, technological development, and training tools,' as part of the National Disaster Preparedness Baseline Assessment (NDPBA) project, which 'focused on risk and vulnerability identification and existing disaster management capabilities' (PDC 2014).

Nepal currently lacks a fully operational Numerical Weather Prediction system, which limits its capacity for flood forecasting (UNESCAP 2016). However, it is equipped with over 286 meteorological stations and 170 hydrological stations, some of which are automated and allow for constant updating. In contrast to the national-local divide in Peru's forecasting, the strong relationship between the Ministry of Home Affairs (MOHA) and local aid agencies in Nepal has arguably led to further forecasting success through installations and upgrades in meteorology and hydrology systems (Practical Action 2016). The installation of these alert tools enable the region to reach what UNESCAP refers to as "end-to-end" monitoring, when the warning and development measures can adequately address both the technical and the societal aspects of warning: mapping hazards, monitoring potential disasters to disseminate information and provide appropriate warning and participation of stakeholders (UN Water 2008).

In instances when communities are limited by technology, or their feedback is not perceived as credible they are prohibited from receiving appropriate warning and aid. Without initial access to adequate flood

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[14] Utilising a combination of meteorological and hydrological expertise, the UK's Flood Forecasting Centre provides intelligence and support to domestic emergency responders and is supporting the World Meteorological Organisation to improve impact-based forecasting (FFC 2017).

forecasting technology, communities face compounded vulnerabilities (Flood List 2015). To enhance the credibility of EWS, NRCS and Practical Action work with rural communities to provide transboundary alerts, ensuring that forecasting systems provide maximum possible warning for communities (Practical Action 2016).

Basic EWS

Without such data or access to isolated communities, forecasting systems can be scaled down to simple and locally appropriate models for maximum efficacy. For example, in Nepal and Peru basic EWS have been implemented to warn communities against a range of hazards, including landslides, flooding and glacial lake outburst floods (GLOFs). The national process for disaster response in Nepal originates in the Disaster Relief Act of 1982, which established MOHA. They are entirely responsible for disaster management through the coordination of disaster activities and post-crises rehabilitation (IFRC 2011). Through collaboration at the local, district and regional level, MOHA works with The Central Disaster Relief Committee. Additionally, MOHA has collaborated with Practical Action teams to assess the requirements for automatic meteorology and hydrology stations to enhance the response time for vulnerable populations in the Kankai region. Has allowed rural communities to move beyond direct observation towards automated systems of warning. The NFRC has further collaborated with rural communities to understand the technical capabilities and utilize FM radios as effective methods to distribute flood warnings.

Historically, monitoring and forecasting capabilities in Peru have developed out of need to protect critical assets and populations from earthquakes, flooding and *huaycos*[15]. These systems have also been developed by state and private companies, such as water plants and mining companies operating in Peru's most at-risk watersheds[16]. However, basic EWS have been generally absent or deficient in remote communities. Many NGOs and CBOs are working to fill in this gap, and increase the population being protected by EWS. Experiences in Peru underscore the challenges in providing the soft-technology to ensure that EWS are valued and maintained by the communities.

Whilst technology must inform risk assessments, it is important to note that it cannot replace local knowledge (Shaw et. al 2016). Technology, furthermore, when implemented from a top-down perspective does little to improve the understanding of risk at the local level, thus undermining risk reduction.

[15] *Huaycos* are known in Peru as torrential down-slope flows of water-saturated earth and rock.
[16] See ANNEX F.

3.5 Communicating Risk

MAIN BARRIERS

- Limited in-country infrastructure capabilities reduce lead-time, limiting response.
- Lack of two-way communication prohibits successful risk dialogue.
- Politicization hinders effective transboundary hazard alerts.
- Challenges to embedding an understanding of roles and responsibilities and thresholds for action.

Risk communication between the decision makers and stakeholders, and between decision makers and the general public, occurs both in the preparedness and the warning phase of the hazard cycle (Figure 3) (Höppner and Buchecker 2010). Communication can be both one-way, in the transfer of hazard and risk-related information and its management; and two-way, in the receipt of aid or in the transfer of knowledge and attitudes (Höppner and Buchecker 2010). The effectiveness of EWS depends on the success of communication of alerts, and varies depending on the stakeholders and the scale to which they are interacting (Höppner and Buchecker 2010). Risk communication and risk perception are highly interlinked and central to previously mentioned systems of risk awareness.

Alerts and Warnings to Action

In the instance of an event, alerts or warnings are emitted to trigger action. The type of warning and action required, however, must be understood by decision-makers and the public. The UK is able to employ extensive high-tech communication technologies to disseminate flood information. "Floodline", the UK's flood warning system, employs a three-tier framework to issue public notifications: alerts, warnings and severe flood warnings. The thresholds of each alert are based on an impact-based assessment of the FFC and range in potential severity from the "possibility of flooding" to "a threat to life" (DEFRA 2009, 6). The Floodline website is updated at 15 minute intervals and employs a "traffic light protocol" to visually identify the severity of warning. Members of the public can pre-register to directly receive warnings by phone, email or text message. In addition to this national mechanism, Lead Local Flood Authorities (LLFA) in England and Wales have a statutory responsibility under the 2004 CCA to share FFC alerts at the local level, and NGOs also provide their own channels of communication to the public (e.g. the British Red Cross Emergency Alert App).

Nepal and Peru both lack the necessary infrastructures to replicate the UK's system of communicating risk. The social, economic and geographic risks facing many of Peru and Nepal's poorest is worsened by limited national soft-tech infrastructures. Therefore, EWS success is dependent on the extent to which it has been localized (NRCS 2015). To meet the needs of the population and operate successfully within the limitations of rural communities CEWS are an essential element in communicating flood risks in rural alpine communities.

The Nepal Red Cross Society (NRCS) has been highly involved in establishing communication networks. CEWSs have been operationalized in eight river basins across the Karnali, West Rapti, Babai, East Rapti, Narayani, Bagmati, Kankai and Koshi basins (DHM 2016). NRCS has 12 siren hotspots in what they have deemed high-risk zones of in Tinau area (NRCS 2015). These are run and maintained by local volunteers and depend predominantly on low-tech observation and alert systems to give communities the maximum lead-time. Additionally, Practical Action Nepal have harnessed the capacity of communities in addressing UNESCAP's goals of enhancing regional cooperation in providing alerts to vulnerable populations located in transboundary flood zones (2016). Unfortunately, given the low-tech system capabilities, communities remain dependent on real-time water readings. These systems typically give 2-6 hours of notice and are contingent on the success of both human and machine monitoring. This limited window creates a greater margin for error, the effects of which directly impact land and livelihoods.

Practical Action Nepal and the NRCS have also been instrumental in developing transboundary SMS communication, ensuring the dissemination of flood information across borders. Ideally such systems enable communities to become active owners and drivers of EWS, rather than passive recipients of information. Whilst risks to flooding exceed national borders in the Andean region, there is currently limited cooperation with neighbours. Although some data collection is shared, cooperation has been more evident in the event of tsunamis. For example, the South Pacific Early Alert System and Tsunami Regional Protocol was implemented with the support of UNESCO and the DIPECHO programme, and included Chile, Colombia, Ecuador and Peru (Cristóbal and Sáenz 2014).

A thorough understanding of risk, the capacity to anticipate risks through correct forecasting, and the effective communication of risk will determine the type of response by all relevant actors. Involvement of the local throughout this process will ultimately make communities "response capable" (ICRC 2012). Finally, we note that the processes reviewed in these sections are constitutive of wider DRR strategies, and should be complemented with other structural and non-structural measures to reduce risk. By identifying the critical barriers to successful EWS implementation we hope to identify recommendations that can provide a foundation for approaching this wider agenda.

4. Challenges to Implementing EWS

The previous analysis of EWS demonstrates that whilst technology can play a significant role in enhancing resilience to hazards, the effectiveness of these technologies relies on several additional critical factors. The language included in the 2015 frameworks reflects the shift toward a people-centred and localised process of DRR, and an understanding of the value of building resilience in the face of anthropogenic climate change. In practice, however, the operationalization of global frameworks-continues to be top-down. Political will to incorporate the local in the process is lacking, and the focus on outcomes rather than the process - which builds soft technology, or the scaffolding for transformational resilience. Despite efforts to establish a shared understanding of response thresholds and embed roles and responsibilities for disaster response, political dynamics and competing institutional priorities often hamper the effectiveness, predictability and inclusivity of response.

Our analysis highlights four main interrelated challenges that emerge in both technology-rich and technology-poor countries that *cannot* be addressed through technological innovation alone. These challenges are summarised below:

Table 1: Challenge Summary

Challenges	Main points identified
I. Overdependence on hard and high technologies, instead of appropriate and soft technologies	• EWS processes fail to translate data into appropriate information for relevant stakeholders and intended beneficiaries. • Technology development and implementation fails to reflect innovative approaches to risk assessment, land-use planning and ecosystems-based approaches. • Technology is frequently developed in isolation from local needs, knowledge and perceptions of risk.
II. Inadequate understanding and communication of risk	• Limited capacity to capture the complexity of multidimensional vulnerabilities undermines the effectiveness of solutions. • Different approaches to risk assessment results in gaps in understanding. • Top-down one-way communication fails to build relationships and trust between agencies and at-risk populations. • Practical challenges and cost impede "last-mile" communication, particularly when it involves remote communities or difference in either language or conception of disasters. • Local capacity and understanding of risk are often side-lined from policy-making.
III. Political and institutional dynamics obstruct progress	• A top-down approach to policy and funding of DRR programmes fails to capture local needs. • Limited coordination and collaboration between actors in DRR and low incentives for sharing information. • Inconsistent regional collaboration to reduce and response to cross-boundary hazards. • Limited resources and in-country capacities leaders to an overreliance on external actors. • Misalignment of incentives and accountability mechanisms between donors and beneficiaries.
IV. Limitations of existing international frameworks	• Incoherence between DRR and development hampers a holistic approach. • Sendai reporting indicators offer limited opportunities to address the strategic priority of establishing a "people-centred" approach of the framework.

Important to note is the extent to which these challenges often combine to present pressures on meeting the needs of the poor, disenfranchised and hardest to reach. In the concluding section of this report, we will identify practical recommendations for a range of actors to overcome these challenges.

5. Recommendations: Towards Transformational Resilience

Through an analysis of the strengths and weaknesses of existing approaches to the development, implementation and roll-out of EWSs, this report has identified four critical barriers to ensuring DRR policies and practices fulfil their potential to contribute to transformational resilience. Efforts to address the unequal benefits of technology will only succeed if they recognise these challenges:

1. Successful technological solutions are dependent on a contextual understanding which recognises local needs and the dynamic nature of disaster risk.
2. Efforts to assess and communicate disaster risk must recognise the complex interplay between hazards, exposure and vulnerability and variations in local and individual risk perception.
3. Political and institutional dynamics often fail to deliver accountability and incentive mechanisms to overcome the above barriers.
4. Progress reporting under current international frameworks has limited potential to leverage change required at the national and local level.

To conclude this report, we have identified three sets of recommendations to improve international frameworks and direct government and NGOs activity to overcome the barriers listed above. Given the significant challenges to shifting entrenched political dynamics at the international and national level, our first recommendation prioritizes activity that can enable greater local understanding, inclusion and input across the EWS process. The implementation of these recommendations within this specific context can provide a first step towards shifting DRR to meets the needs of intended beneficiaries more widely.

Whilst systems of localization and beneficiary-centred approaches have gained greater emphasis across development policy and practice, their application to DRR has been limited (Lindsey et al. 2015). Our second set of recommendations suggests that by including a wider informational base in the measurement of DRR progress, policy priorities can be shifted from a top-down to a bottom-up approach. Insights and experiences from developing a more localised approach to EWSs can contribute to the political impetus to progress this work and ultimately deliver a more holistic approach that accurately captures local needs and levels of preparedness (Tanner et al. 2015).

Finally, we reaffirm the value in embedding DRR efforts within an understanding of the need to strive for "transformational resilience". Whilst we recognise that Sendai has made significant progress in a politically contentious space, we argue that it is only by addressing the root causes of disasters and engaging in a “radical critique" of global socio-economic vulnerabilities that the framework can meet its stated objectives (UKADR 2017). In an era of increasing climate risk, the below recommendations offer a pathway to build on successes in existing EWS approaches, to demonstrate the value in a bottom-up approach and progress towards transformational resilience in the longer term.

<table>
<tr><th colspan="3">Recommendation One: Embed the Local in the Design, Development and Roll Out of EWSs</th></tr>
<tr><td>International Frameworks</td><td>National Governments</td><td>NGOs</td></tr>
<tr><td rowspan="2">1a) Support information sharing between regional platforms and promote best practices for including the local in EWS approaches.</td><td colspan="2">1b) Develop partnerships to ensure technological “user-needs” reflect existing (NGO) knowledge of socioeconomic vulnerabilities e.g. focus on the needs of specific groups facing known drivers of vulnerability such as the old and the impoverished in the initial design and development of EWS technology.

1c) Invest in developing multi-sector forums and communication channels to facilitate regular two-way risk communication between the intended beneficiaries of EWSs and policy-makers and EWS operators to raise local risk awareness and improve trust in risk management agencies.

1d) Invest in the development of locally owned innovation centres to incubate the development of technology at the local level.</td></tr>
<tr><td>1e) Incentivise new local engagement processes across EWSs by highlighting good practice at the local government level and by NGOs.

1f) Highlight the successes and failures of meeting local needs and the needs of the most vulnerable in post-disaster reviews and evaluation to support mutual learning and innovation.

1g) Review the strengths and limitations of the insurance market to provide cover and drive greater engagement in disaster risk management. Consider subsidies and review regulatory frameworks to ensure affordability for the most vulnerable.</td><td>1h) Engage in training, education and awareness-raising activity to improve local understanding of disaster risk.

1i) Harness the potential of existing local technology capabilities (such as FM radio and SMS) to facilitate local engagement across the EWS process.</td></tr>
</table>

Recommendation Two: Establish the Local as the Benchmark for Success		
International Frameworks	*National Governments*	*NGOs*
2a) Shift focus from global comparability at the national level to prioritise the development of reporting indicators that assess levels of preparedness at the local level. 2b) Align work streams developing reporting indicators for 2015 resilience related framework to drive this agenda. 2c) Involve NGOs with local access and knowledge in the development of progress indicators.	2e) Provide training and guidance to local government to build capacity to assess levels of local risk and resilience.	2f) Where it exists, utilize local access and local knowledge to support efforts to understand local risk and to inform the measurement of progress. 2g) Actively contribute local insights to the development of reporting indicators for 2015 frameworks.
2d) Establish knowledge-sharing platforms to assess the potential use of subjective indicators to assess resilience to disaster risk. Draw on the expertise in the development of subjective 'well-being' and human development indicators.		

Recommendation Three: Strive for Transformational Resilience		
International Frameworks	*National Governments*	*NGOs*
3a) Establish a shared understanding, and embed the language of transformational resilience across currently distinct international agendas. 3b) Establish formal linkages between existing international frameworks that contribute to transformational resilience.	3d) Ensure a government-wide approach to transformational resilience that incorporates national and the local policy expertise in livelihoods, ecosystems and land-use planning. 3e) Develop standardized risk assessment methodologies to ensure coherence and comparability across different sectors and regions. 3f) Engage in regional and international cooperation to address transboundary risks. 3g) Develop mechanisms to assess investment decisions based on their long-term transformational potential.	3h) Establish partnerships with actors working across the transformational resilience agenda to ensure holistic programming that addresses the root causes of disaster risk. 3i) Promote localisation to ensure local ownership of efforts to address the root-causes of disaster risk. 3j) Undertake advocacy campaigns that highlight the root-causes of disaster risk to shift policy priorities of donors and national government.
3c) Explore mechanisms to involve local input and the most vulnerable into the design of future international frameworks.		

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ANNEX A: Terms of Reference

Practical Action: Disaster Risk Reduction and Technology

1. Introduction

The present document summarises the terms of reference of the consulting study, as established by Colin McQuistan, Climate Change and Disaster Risk Reduction senior adviser at Practical Action: UK, and Jordan DeLorenzo, Mariana Gutierrez and George Woodhams, graduate students at the London School of Economics and Political Science.

Any modifications to the present ToR will be first discussed with Practical Action UK Office.

2. Background

Practical Action is an international non-governmental organisation that works alongside communities to find practical solutions through technology to challenge the poverty they face. One of its main programmes is centred around Disaster Risk Reduction (DRR), and the employment of technologies that can increase a community's resilience to natural disasters. Practical Action's most recent experience in DRR has been focused on the implementation of early flood warning systems in Nepal.

Practical Action is concerned with the disjunction between the vulnerabilities of a community, and the adoption of effective, appropriate and durable DRR technology in both technology-rich and technology-poor countries, that informs response and future planning. Through this study, we strive to shed light on the factors that influence this disjunction by analysing case studies in the Andean Region- and compare them to similar systems in both Nepal, and the UK to provide recommendations for the actors involved in the development of DRR technologies.

3. Objectives

The LSE team will provide insight into the different factors that influence the design, distribution and adoption of early flood warning systems in the United Kingdom, Nepal and the Andean Region. This investigation will attempt to frame the vulnerabilities of communities affected by flash floods in these areas, and map the incentives and market forces that determine the effectiveness, appropriateness and durability of these technologies to enhance local resilience.

4. Scope

The LSE team will explore information in view of answering the following guiding questions:

1. Understanding vulnerabilities and identifying hazards at the community level
    - a. What are the physical, social, political, economic and temporal dimensions of vulnerability to natural hazards?
    - b. To what extent do socio-economic factors determine community vulnerability to hazards?
    - c. To what extent do rural/urban divides, livelihoods and political contexts affect vulnerability?

2. Actors and Approaches to Resilience
    - d. What are the current efforts and resources of governments, international organisations, non-government organisations, companies and communities to develop and employ early flood warning systems in the UK, Nepal and the Andean Region?
    - e. What constitutes effective, appropriate and durable DRR technologies?
    - f. What roles, incentives and responsibilities do global, regional and local actors have for the design, development and adoption of DRR technologies in diverse contexts?
    - g. What are the institutional frameworks that determine their decision-making?
    - h. How do levels of engagement and systems of accountability affect outcomes at the community level?
    - i. To what extent do market forces affect investments and decision-making relating to DRR technology?
    - j. How does the flow of the information provided by EWS limit or enhance the technology's capacity to enhance local resilience?

With the development of the project, new questions or research areas may arise. Any new research topics will first be discussed with Practical Action.

3. Methodology

The LSE team will use any of the following methodologies and procedures, in close coordination with Practical Action:

- Desktop research: open sources, such as media outlets, journals, and specialized blogs

- Literature review: academic journals and databases
- Interviews with practitioners and experts in our regions of interest
- Consultation with groups and individuals in the humanitarian and development sectors
- Meetings with the staff of Practical Action offices
- Frequent feedback with Practical Action

4. Roles and Responsibilities

The LSE team will be mainly responsible for the following tasks:

- Develop analysis framework for the study
- Prepare list of documents to review
- Carry out literature review/ review documents
- Organise interaction with stakeholders
- Analysis and report preparation
- Present draft report and collect feedback
- Prepare and submit final report

Practical Action Nepal Office will be responsible for the following tasks:

- Help the consultants to understand their framework for (relative) success;
- Assist the consultants in developing an understanding of emergency vs long-term development responses in DRR;
- Provide documents related with Practical Action to review; and
- Provide feedback to the framework, tools and report on time.

Practical Action South America will be responsible for the following tasks:

- Help the consultants to understand the needs of Practical Action South America better;
- Outline cultural, economic, geographical, political and social constraints facing their work in the region
- Provide documents related with Practical Action to review; and
- Provide feedback to the framework, tools and report on time.

5. Deliverables

The LSE team will deliver:

- Draft inception report by 9 November 2016
- Draft interim report by 7 December 2016
- Draft report by 20 February 2017
- Final report by 10 March 2017
- Presentation of our report to Practical Action by 15 March 2017

Prior to the submission of the final report, each deliverable should generate feedback from Practical Action to improve the research process.

6. Contact

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ANNEX B: Interviews

To support our research, we were able to conduct interviews with the following key stakeholders:

Table 2: Interviews Conducted for this Study

Name(s)	Position, Organisation	Date of Interview
Gopal P. Ghimire	Project Manager-Nepal Flood Resilience Project **Practical Action South Asia**	23 January 2017
Simon Lewis	Head of Crisis Response **British Red Cross**	15 February 2017
Not disclosed for privacy purposes	Practical Action Bolivia	23 December 2016
Sagar Shrestha	Programme Coordinator of Disaster Management Department **Nepal Red Cross Society**	23 February 2017
Emilie Etienne	Project Manager "*Aliados ante Inundaciones*" Disaster Management and Climate Change Adaptation Programme **Soluciones Prácticas – ITDG (Practical Action Peru)**	23 January 2017
Pedro Ferradas	Project Manager Disaster Management and Climate Change Adaptation Disaster Management and Climate Change Adaptation Programme **Soluciones Prácticas – ITDG (Practical Action Peru)**	23 January 2017
Lindsey Jones	Research Associate Risk and Resilience Programme **Overseas Development Institute**	6 February 2017
Nestor Alfonzo Santamaria	Senior Risk Policy Advisor **Civil Contingencies Secretariat** UK Cabinet Office	1 December 2016
Ipek Aybay	**Edinburgh University**	12 November 2016
Colin McQuistan	Senior Policy and Practice Adviser Climate Change and Disaster Risk Reduction **Practical Action UK**	November 2016-February 2017

ANNEX C: Emerging Vulnerability Indices

Table 3: Theoretical Indicators of Social Vulnerability

Thematic indicators	Specific indicators
Coping capacity	• Individual capacity • Household capacity • Social capacity
Demographic characteristics	• Age • Race and ethnicity • Family structure • Gender • Functional needs • Language proficiency
Health	• Access • Stress • Disease • Mortality • Sanitation
Land tenure	• Owners • Renters • Squatters
Neighbourhood characteristics	• Transportation • Population density • Housing • Resource dependency
Risk perception	• Awareness • Prior experience • Knowledge of flood protection measures • Risk denial/acceptance • Trust in officials
Socioeconomic status	• Income • Wealth • Education • Occupation

Source: Rufat et al 2015

ANNEX D: Sendai Framework

The Framework's seven global targets are:

(a) Substantially reduce global disaster mortality by 2030, aiming to lower the average per 100,000 global mortality rate in the decade 2020–2030 compared to the period 2005– 2015;

(b) Substantially reduce the number of affected people [MG1] globally by 2030, aiming to lower the average global figure per 100,000 in the decade 2020–2030 compared to the period 2005–2015;

(c) Reduce direct disaster economic loss in relation to global gross domestic product (GDP) by 2030;

(d) Substantially reduce disaster damage to critical infrastructure and disruption of basic services, among them health and educational facilities, including through developing their resilience by 2030;

(e) Substantially increase the number of countries with national and local disaster risk reduction strategies by 2020;

(f) Substantially enhance international cooperation to developing countries through adequate and sustainable support to complement their national actions for implementation of the present Framework by 2030;

(g) Substantially increase the availability of and access to multi-hazard early warning systems and disaster risk information and assessments to people by 2030.

Four Priorities for Action:

1. Understanding disaster risk.
2. Strengthening disaster risk governance to manage disaster risk.
3. Investing in disaster risk reduction for resilience.
4. Enhancing disaster preparedness for effective response and to "Build Back Better" in recovery, rehabilitation and reconstruction.

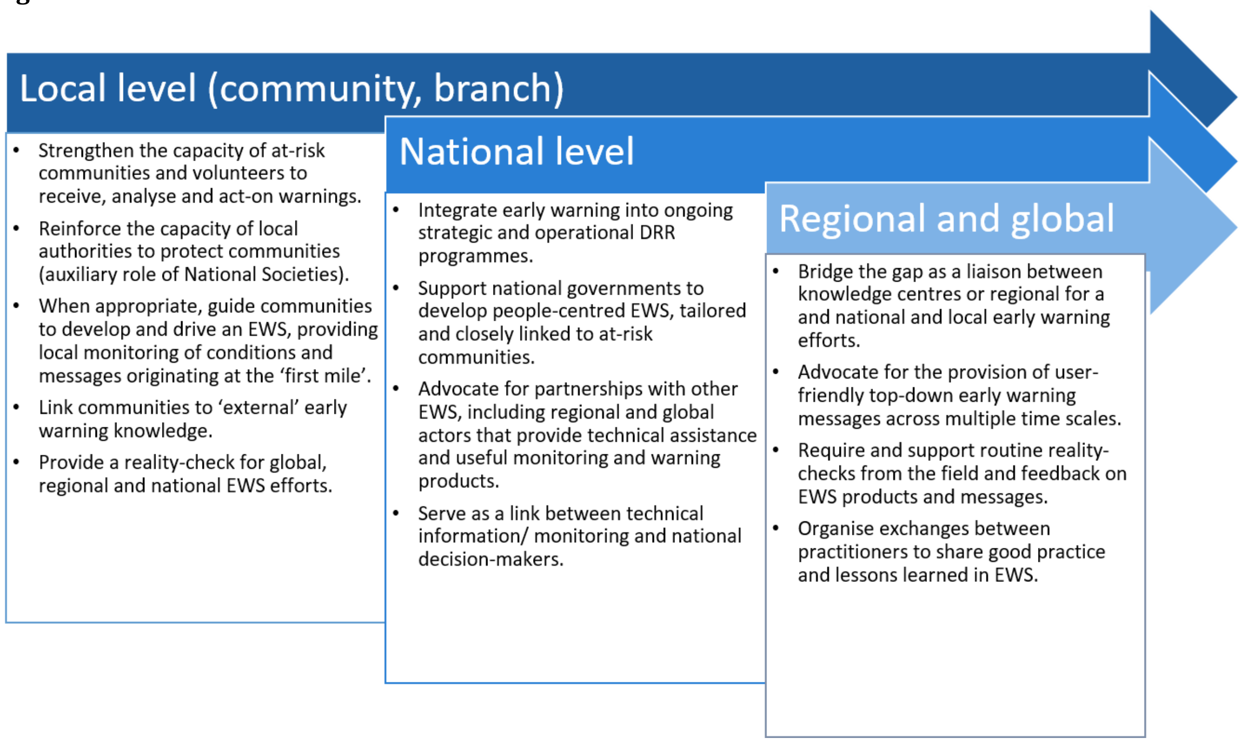
The following indicators established by the OIEWG in January 2017 to measure progress against target G.

Target G: Substantially increase the availability of and access to multi-hazard early warning systems and disaster risk information and assessments to the people by 2030.	
G-1	Number of countries that have multi-hazard early warning systems.
G-2	Number of countries that have multi-hazard monitoring and forecasting systems.
G-3	Number of people per 100,000 that are covered by early warning information through local governments or through national dissemination mechanisms.
G-4	Percentage of local governments having a plan to act on early warnings.
G-5	Number of countries that have accessible, understandable, usable and relevant disaster risk information and assessment available to the people at the national and local levels.
G-6	Percentage of population exposed to or at risk from disasters protected through pre-emptive evacuation following early warning.

ANNEX E: Roles for End-to-End EWS Practitioners

In 2012, ICRC published a report compiling guiding principles for community early warning systems, based on extensive consultation of National Societies, Red Cross Red Crescent Reference Centres and the International Federation of Red Cross and Red Crescent Societies; international and national partners; and the World Meteorological Organization. The following diagram portrays ICRC's understanding of the different roles of EWS practitioners at the local, national and regional and global levels.

Figure 4: Roles of EWS Practitioners



Source: ICRC 2012

ANNEX F: Country Comparison of Risk Profile and Current Legal Frameworks

The following table summarises the high-level risk profile of each case study, and their current DRM institutional frameworks and DRR strategies. It further provides each country's INFORM risk index which it incorporates three dimensions of risk: namely hazards & exposure, vulnerability and lack of coping capacity dimensions; and INFORM's ranking of each country.

Table 4: Country comparison of risk profile, institutional framework, and implementation of EWS

	Risk profile	Recent cases	Institutional framework	Strengths and Challenges	Implementation of flood EWS
UK **INFORM Risk 2.0** **Rank: 153**	**Hazards** *Meteorological hazards:* Flooding from coastal, river and surface water **Vulnerability** 1 in 6 homes in England are in areas at risk of flooding (Environment Agency).	**2007 Summer Floods** (Cost £6.5 billion; 55,000 properties flooded) **2014 Floods in the South East** **2015/16 Storm Desmond** (Cost £1.3 billion; 19,000 properties flooded)	Civil Contingencies Act of 2003 National Civil Contingencies Secretariat (Cabinet Office) is responsible for the: -National Risk Assessment / Register -Dept. Environment Food and Rural Affairs (DEFRA) -Environment Agency (EA) -Lead Government Department (LGD) for Flooding risk -68 Catchment Flood Management Plans (CFMP), grouped by river basin district Flood Forecasting Centre, operated by the Met Office and EA Local agencies: -Lead Local Flood Authorities (LLFA) -Local Resilience Forums (LRFS) LLFA and EA develop local risk assessments and Flood Risk Management Plans (FRMP)	The HMG has made efforts to consider and plan for specific local vulnerabilities and critical assets. Campaigns target pre-identified vulnerable groups, informing them based on the local context in which they are situated. Information sharing platforms allow for effective emergency response. "Resilience Direct", a common mapping platform, enhances information sharing. LRFS allow for greater civil participation in local planning. **Challenges:** Better incorporating risk awareness in decision-making and land-use planning	National Flood Forecasting Centre, a joint enterprise between EA and Met Office, and Local Authority are responsible for EWS

	Risk profile	Recent cases	Institutional framework	Strengths and Challenges	Implementation of flood EWS
Peru **INFORM Risk 4.1** **Rank: 76**	**Hazards** *Geological hazards:* High seismicity, volcanos and landslides *Meteorological hazards:* Floods, flash floods, torrential storms and droughts (El Niño phenomenon), GLOFs **Vulnerabilities** Marginalized populations, urban poverty, unplanned urban development poor infrastructure, soil and water quality degradation, surge of illegal settlements	In 2010 a block of ice fell from the Hualcán mountain and created a 28-meter wave in a lagoon (Laguna 513) located on the foot of the glacier. In 2010, torrential storms in Cusco caused extensive flooding, *huaycos* and landslides, which damaged critical infrastructure. In 2015, riverine floods affected over 150,000 people (EMDAT). In January 2017, torrential storms lead to flooding, landslides and *huaycos* in Southern Peru.	In 2002, Peru started a decentralization process for disaster management. Regional government responsibilities were delimited, and regional Civil Defence Systems (SIDERECI) and local committees of civil defines (CDC) were created. May 2011: Law 29664 created the National Disaster Risk Management System (SINAGERD), and incorporated a DRM approach. In May 2014, the National Plan for Disaster Risk Management 2014-2021 (PLANAGERD) was approved. Regional and local governments are the main authorities for executing DRR processes. Peru has improved response to disasters through establishing the National Humanitarian Network, in coordination with the local UN office and INDECI.	Peru initiated reforms to decentralise its disaster risk governance, much in accordance with Hyogo. Whilst it continues to be in a phase of implementation, it is increasing capacity to implement both structural and non-structural measures of DRR. **Challenges**: - Deficient implementation of DRR national policy -Poor funding for district and municipal governments, and for entities in charge of collating risk information - Deficient collaboration between agencies involved in risk assessment - Poor urban and infrastructural planning remains a challenge	Since the early 2000's, flood EWS system have been implemented in different regions of Peru. These systems have been inconsistent. In 2015, the general guidelines for the National Early Warning System Network (RNAT) were approved. INDECI oversees the development of EWS in Peru. the focus is still primarily on single-hazard systems. Private sector involvement in monitoring systems for flooding.

	Risk profile	Recent cases	Institutional framework	Strengths and Challenges	Implementation of flood EWS
Nepal **INFORM Risk 5.4** **Rank: 35**	**Hazards** *Geological hazards:* High seismicity, landslides and erosion. *Meteorological hazards:* Annual monsoon season, riverine floods, flash floods, GLOFs **Vulnerabilities** Marginalized populations; poor infrastructure; unsustainable production systems; extreme alpine conditions; and rural–urban, geographical, gender, and caste/ethnic divisions	In 2013, the Mahakali flood in Darchula District affected 4,400 people and displaced 2,500 in Darchula. In 2014, the Sunkoshi landslide in Jure village of Sindhupalchok District caused more than 150 casualties and 400 displaced. The landslide also disrupted critical infrastructure. In July 2016, flash floods and landslides in the Nawalparasi region (Central) resulted in 102 dead, 20 missing, and 6,000 people left at risk	National Calamity (Relief) Act 2039 (1982) on disaster response established the Ministry of Home Affairs (MOHA). National Strategy for Disaster Risk Management in Nepal (NSDRM), based on Hyogo, was approved in 2009. The Nepal Risk Reduction Consortium, in collaboration with development and humanitarian partners, has a lead role in the implementation of the NSDRM. Nepal also has developed a legal framework for community based disaster risk reduction (CBDRR), and local governments participate and collaborate with other actors through Community Disaster Management Committees (CDMCs).	Nepal has been very successful in supporting local processes in DRR, which has built a solid *soft technology* platform. Involvement of multiple actors in the NSDRM and CDMCs allows for leveraging distinct skill sets, better coordination and ownership of DRR strategies at the local level. **Challenges:** The Nepalese government still faces significant challenges in improving forecasting and monitoring, particularly a rainfall monitoring system. Whilst the government has pushed forward DRM activities, most of these are limited only to “blueprint” -- implementation is still very weak.	In Rupandehi, Buddhanagar: 12 siren hotspots operated by the Red Cross and District Disaster Rescue Committee and local volunteers. CEWS are now operational in eight river basins across Nepal (Karnali, West Rapti, Babai, East Rapti, Narayani, Bagmati, Kankai and Koshi basins)

Note: Data compiled from various sources, including our interviews with stakeholders, GFDRR 2010, Picard 2011, Bruni 2015, Gaire et al. 2015, OECD 2016, Schneider et al. 2013, EM-DAT, INDECI, INFORM and UK