Science for Humanitarian Emergencies and Resilience (SHEAR) scoping study:

Annex 3 - Early warning system and risk assessment case studies

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Early warning system and risk assessment case studies

This report provides case studies of Early Warning Systems (EWSs) and risk assessments encompassing three main hazard types: drought; flood and cyclone. The case studies are taken from ten countries across three continents (focusing on Africa, South Asia and the Caribbean).

The case studies have been developed to assist the UK Department for International Development (DFID) to prioritise areas for Early Warning System (EWS) related research under their 'Science for Humanitarian Emergencies and Resilience' (SHEAR) programme.

The aim of these case studies is to ensure that DFID SHEAR research is informed by the views of Non-Governmental Organisations (NGOs) and communities engaged with Early Warning Systems and risk assessments (including community-based Early Warning Systems).

The case studies highlight a number of challenges facing Early Warning Systems (EWSs). These challenges relate to financing; integration; responsibilities; community interpretation; politics; dissemination; accuracy; capacity and focus.

The case studies summarise a number of priority areas for EWS related research:

- Priority 1: Contextualising and localising early warning information
- Priority 2: Climate proofing current EWSs
- Priority 3: How best to sustain effective EWSs between hazard events?
- Priority 4: Optimising the dissemination of risk and warning information
- Priority 5: Governance and financing of EWSs
- Priority 6: How to support EWSs under challenging circumstances
- Priority 7: Improving EWSs through monitoring and evaluating the impact and effectiveness of those systems

SECTION 1

Summary of findings

1.1 Background to the case studies

The objective of the 'Science for Humanitarian Emergencies and Resilience' (SHEAR) scoping study is to provide the Department for International Development (DFID) with evidence based recommendations for future research on risk assessments and Early Warning Systems (EWS). This scoping study is focused on early warning systems and risk assessments, for humanitarian and development purposes, for weather related hazards (e.g. cyclones, floods and droughts) in low-income countries across Africa, the Caribbean and South Asia.

Practical Action Consulting (PAC), the consultancy subsidiary of the International Non-Governmental Organisation Practical Action, is supporting HR Wallingford in the completion of this scoping study. PAC is drawing upon our experience in community-based early warning systems and risk assessments, and our close links with Non-Governmental Organisations (NGOs) and other relevant stakeholders; in order to document Early Warning System (EWS) case studies and to highlight NGO perspectives on EWS related research gaps.

The aim of these case studies is to ensure that research priorities identified under the SHEAR Scoping Study are informed by the views of NGOs and communities engaged with Early Warning Systems (including community-based Early Warning Systems).

Case studies were selected to cover a range Early Warning Systems, relevant to a range hazards, across Africa, the Caribbean and South Asia. Interviews were conducted with a range of stakeholders (see Appendix B for an abridged list); together with desk reviews of NGO internal and external documents (see Appendix A for an abridged list).

Each case study sought to document information on:

- **Context** (providing background information on the hazard, the number of people affected, and the scope of the system)
- **Current status** (analysing the current functioning of the EWS, including consideration of sustainability, opportunities to scale up and challenges to EWS effectiveness)
- **Current research** (providing NGO perspectives on current or planned research of relevance to each EWS).
- **Research gaps and priorities** (highlighting the research gaps and areas where further research would be most valuable from the perspective of NGOs, communities and end users).

1.2 Case study overview

The selected case studies encompass three continents, 10 countries and three main hazard types: drought, floods and cyclones. Case studies were selected to give a breadth of focus, ranging from new EWSs (e.g. Uganda, 2008) to established ones (e.g. Bangladesh 1970s),

and ranging from highly technical and sophisticated systems (the Drought Early Warning System (DEWS) in Kenya) to systems in the early stages of development (Sudan). The case studies also cover a variety of scales, from nationwide government led systems (Burkina Faso), through to smaller NGO led pilots (Malawi) and community based EWSs (Nepal). One to four case studies were collected from each region (East and Central Africa, Southern Africa, West Africa, the Caribbean and South Asia).

Region	Country	EWS	Hazard Type
East/Central Africa	Sudan	Sudan's Climate Early Warning System	Drought
East/Central Africa	Kenya	Kenya's Drought Early Warning System	Drought
East/Central Africa	Uganda	The Karamoja Drought Early Warning System.	Drought
West Africa	Burkina Faso	Drought Early Warning with the Household Economy Approach	Drought
West Africa	Niger	Niger's Drought Early Warning System	Drought
Southern Africa	Zimbabwe	Zimbabwe's Drought Early Warning System	Drought
Southern Africa	Malawi	Flood Early Warning Systems in Malawi	Floods
South Asia	Nepal	Community-Based Early Warning Systems	Floods
South Asia	Bangladesh	Bangladesh's Flood Forecasting and Early Warning System	Floods
South Asia	Bangladesh	Cyclone Early Warning and Volunteerism in Bangladesh	Cyclones
Caribbean	Dominican Republic	Tamayo Early Warning System	Floods

Table 1. Overview of case studies

1.3 Key challenges

The case studies highlight a number of recurring challenges to the effectiveness, scale up and sustainability of early warning systems. These challenges can be categorised around certain themes.

1. Defining roles and responsibilities

In many systems the distinct roles, responsibilities and mandates of different institutions/bodies engaged in EWS have not been clarified. Overlaps create competing approaches and duplication of effort, whilst some areas are neglected entirely. These national challenges are often felt even more strongly at sub-national and community level, both between and within different departments/ministries/agencies. During periods of institutional change and reform (e.g. when new institutions are formed, or during processes of decentralisation), these challenges are further exacerbated. Ownership at all levels is essential for a functional EWS.

Typically there are a large number of agencies and organisations involved in supporting an EWS, and coordination and cooperation remains a challenge, particularly where there is no guiding framework, policy or consensual vision underpinning the EWS. Having a vision and consensual framework is critical as most national government agencies with an early warning mandate are focused narrowly on emergency preparedness and response, without

necessarily prioritising linking up with other actor or other parts of government, including those mandated to tackle underlying causes of risk. Coordination and cooperation challenges are significantly multiplied in areas where trans-boundary or transnational cooperation is required.

2. Targeted and sustainable financing

Short-term, unpredictable funding, or even the absence of designated funding for EWSs, continues to be a challenge in many countries. Financing challenges are multiplied where roles and responsibilities are not clearly assigned, leaving gaps in responsibility for financing actions at community, sub-national and national levels, as well as confusion over responsibility for financing distinct EWS components (e.g. dissemination of information, capacity building, maintenance and upkeep of hydro-meteorological stations).

3. Institutionalisation and integration

A key precursor to scaling up and promoting the sustainability of community level EWS is ensuring that the EWS becomes integrated into local government policies, plans and institutions, with support from national government legislation, policies, plans and budgets. This remains a challenge to many community based EWSs.

4. Warning interpretation at community level

National or sub-nationally developed warning systems are not always appropriate for, or applicable to, local communities. Without interpretation and contextualisation, warning information may not effectively prompt an appropriate response by communities.

For an effective EWS, it is essential that the system is linked to local risk and hazard assessments, and that these are developed with, and understood by, communities. One challenge to an effective EWS relates to threshold levels of 'danger' and how such thresholds will be interpreted by communities, especially those located far from data collection sites.

5. Political obstacles to effective EWS

Political obstacles can impede effective EWS, particularly in areas where there is conflict, weak governance, or corruption. Developing an effective EWS is especially challenging in scenarios where there are restrictions on data collection, analysis and information sharing.

EWS effectiveness is severely compromised where warning information is politically manipulated or suppressed. In situations of political interference or corruption, or where there is a lack of trust in the credibility, objectivity and reliability of assessment, the legitimacy and acceptance of the system can be undermined.

6. Dissemination of information

One of the greatest technical challenges within an EWS is the processing and transmission of weather and climate information to users, ensuring that relevant, accessible and timely information reaches end users, especially the most vulnerable within affected communities.

Dissemination challenges are heightened where there are language barriers, high levels of illiteracy, weak infrastructure, a lack of access to phones or radios, and geographically remote, scattered or mobile populations.

Capacity to effectively disseminate warning messages at local level remains a significant challenge, and there remains uncertainty about which dissemination methods are most appropriate and cost effective under which circumstances.

7. EWS accuracy and appropriateness

It is difficult for an EWS to gain national (or regional) recognition and support without agreement on the indicators and methodologies to be applied, as well as consensus on the processes and approaches to data collection, monitoring, analysis and sharing.

Whilst there remain disagreements over appropriate methods of gathering and analysing early warning data, the acceptability of early warning will be compromised. Disagreements over the accuracy and appropriateness of EWS methodologies is a major impediment to EWS effectiveness, leading to duplication of efforts (different organisations undertaking parallel processes), conflicting messages to communities and policy makers, and inertia or disengagement from early warning.

8. Weaknesses in national or local capacity

Several of the case studies highlighted threats to the sustainability of an EWS when the system is reliant on external specialists for the technical support and maintenance of instruments vital for data collection and dissemination. Technical competence needs to be built and maintained through training, and refresher courses. Lack of local capacity to operate, maintain or repair EWS equipment is another barrier to the system's effectiveness.

9. Narrow focus on preparedness

An EWS which is narrowly focused on disaster preparedness fails to create or build synergies with disaster risk reduction, climate change adaptation, multi-hazard EWS or EWS that carry other in-demand information. A joined up approach that includes the above mentioned elements would help to focus government priority and resources, leading to greater efficiencies and better ensuring the sustainability of the system.

10. Distinction between EWS for slow and rapid onset emergencies

The term Early Warning System is utilised for both rapid and slow onset emergencies, as is shown throughout the case studies, and conclusions and recommendations for one type may not be directly applicable for the other type. Risk assessments similarly will differ depending on whether risk is extensive or intensive. There are merits in more careful consideration of the differences in approach needed for effective EWS designed for slow-onset or rapid onset emergencies, as well as whether or how the same system can effectively serve both.

1.4 Recommended priority areas for EWS research

The case studies taken from across Africa, South Asia and the Caribbean highlight a number of EWS research priorities and recommendations, which are summarised below.

Priority 1: Contextualising and localising early warning information

1.1 How to tailor national or sub-national warnings to local levels (tailored to district, sub-district or community level), and how to manage this process from a national level?

1.2 How to contextualise or translate early warning information so that it is meaningful and actionable for community members[1]?

1.3 How to capture risks dynamics that take place at different scales (and the synergies between those). Some price signals or even climatic phenomena are only detectable at

[1] e.g. Accompanying drought warnings with advice on crop types, planting techniques, yield predictions and market prices, or translating general flood warnings into location specific warnings in terms that will be understood in at risk communities.

national/ international scales, how can such data be incorporated into the risk assessments underpinning EWS.

Priority 2: Climate proofing current EWS

2.1 Are current systems resilient under changing risk patterns, and are they effectively building upon complementarities between disaster preparedness, disaster risk management and climate change adaptation? Many risk assessments and hazard maps developed for the purpose of designing early warning systems don't consider possible climate scenarios. It is therefore important to determine whether or not current EWSs are currently climate resilient, and what is required to ensure they become climate resilient.

2.2 It is also noted that in order for EWS research and practice to be effective under a changing climate, it will be important to ensure strong linkages between EWS researchers or practitioners and those engaged with climate science[2].

Priority 3: How best to sustain effective EWSs between hazard events?

3.1 Analysis of the sustainability of volunteer based EWSs

3.2 Analysis of how best to scale up single hazard EWSs into multi-hazard early warning systems

3.3 Exploring how to optimise the system in order to disseminate other types of information (e.g. such as livelihood-related information) outside of hazard events or during low risk periods, and how to best do this whilst ensuring the system's effectiveness is maintained and that early warning for the original hazard is not negatively impacted

Priority 4: Optimising the dissemination of risk and warning information

To transform early warning information into action it is necessary to transform data with language, symbols or references which are understood by vulnerable communities. New methodologies are required to improve the way that outputs (such as risk maps and simplified data) are communicated to communities. This area of research would consider:

4.1 A review of which communication methods are most effective[3], including state of the art ICTs and more traditional methods.

4.2 Which dissemination mechanisms effectively reach those who are most vulnerable?

4.3 Research on community risk perception and reactions to probability based forecasts and warnings.

Priority 5: Governance and financing of EWS

5.1 Research is needed to analyse 'fit for purpose' funding mechanisms and priorities for EWS to ensure that financing is sufficient, targeted to where funds are most effective, and

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2 An example from Africa to illustrate this would be to support cross-collaboration with research groups undertaking the 4 "Key priority areas for climate research to serve development needs" emerging from the African Climate Change Conference in Arusha (October 2013).

3 In terms of number of people reached, the information being understood by the recipients, and also the choice of methods which give rise to improved outcomes/improvements in response.

financed in a way that is both predictable and sustainable. This could include consideration of if, and how, contingency and response budgets can be realigned to support early warning.

5.2 An assessment of how to overcome EWS governance and management challenges:

i) How to institutionalise and hand over successful community pilots to government?
ii) How to include accountability mechanisms into EWSs to improve effectiveness?
iii) How to optimise community level EWS governance structures and mechanisms to ensure sustainability and true community ownership?

5.3 Research to improve the link between Early Warning and Early Action, in particular around effective triggers or indicators to prompt timely a) decision making, b) response and c) release of contingency funds.

Priority 6: How to support EWSs under challenging circumstances

6.1 In locations with frequent disasters and high risk of hazards, and where the current EWS is weak or basic, identifying what steps can be taken to build capacity across the system.

6.2 In circumstances of weak national leadership and governance, lack of political support for EWS (or proactive blocking of early warning messages and information), or under conditions of conflict, what EWSs are most effective, and what actions can be led at the community level?

Priority 7: Improving EWSs through monitoring and evaluating the impact and effectiveness of those systems

7.1 In order to optimise EWSs it is important to be able to monitor and evaluate their effectiveness and impact. This is an area for trans-disciplinary collaboration, NGOs can help scientists to identify appropriate impact outcomes and indicators, and scientists can help NGOs (and ultimately communities) develop a more valid and reliable monitoring and evaluation system for EWS.

7.2 Research is also needed to promote an iterative risk management approach to EWS, ensuring that evaluation of hazard events and early warnings translates into EWS redesign and improvement.

<u>Other priorities for consideration:</u>

- How to enhance lead time to improve early warning of sudden onset hazard events?
- How to improve trans-boundary/trans-national collaboration and information sharing (especially for river basin flood forecasting)?
- Given the many tools and frameworks for risk assessment and Early Warning, research can investigate more deeply the co-relation and complementarity between different methods and tools, and assess opportunities for integration.
- How can partnerships be enhanced to enable improved EWS at cross-regional, national and subnational levels? How to effectively broker collaboration between scientists, government institutions, NGOs, Community Based Organisations (CBOs) and communities.

<u>Cross-cutting EWS research recommendations</u>

Research should be demand driven (involving EWS practitioners and end users in research design).

Research should promote trans-disciplinary and trans-organisational collaboration to ensure that researchers target real life EWS scenarios. Research can be an opportunity to establish collaborative learning partnerships between modellers, practitioners and policy makers to ensure that scientists, practitioners and policy makers share information, collaborate towards shared goals and ensure that EWSs are optimally designed to meet the needs of communities and to meet the ultimate aim of saving lives.

SECTION 2

Case studies from East and Central Africa

2.1 Sudan: Sudan's Climate Early Warning System (SCEWAS)

Background

Sudan suffers from persistent drought and water scarcity, which is exacerbated by long-term cycles of conflict[4]. Sudan has been politically unstable since independence. There have also been four cycles of persistent droughts over this time: 1983, 1997, 2000, 2011 and 2013. There are trends of declining rainfall in some parts of the country[5], which is exacerbating recurring drought, displacement and even loss of human life[6]. Rainfall is highly important for this region, but rainfall data is difficult to obtain[7].

There has been limited focus on Early Warning Systems in Sudan, except for the FEWS NET (funded by USAID), which operates in the greater Horn of Africa covering food security alerts[8]. World Food Programme Sudan uses data from FEWS NET (rainfall) and the Normalized Difference Vegetation Index (NDVI) internally for coordinating humanitarian response strategies. FEWS NET has expertise on climate and weather science. It publishes monthly food alerts that include reliable climate analysis. The Sudan Met Authority (SMA) also produces Sudan Seasonal Monitor Issues (SAMIS), summary bulletins of seasonal weather, current weather and long-term weather predictions for the next season. Ministries of Water and Agriculture provide water and soil data such as river flows, ground water and soil moisture characteristics. The Higher Council for Environment and Natural Resources (HCENR) undertakes climate risk analysis and is in charge of climate change and adaptation plans, supported by the UNEP. It also deals with monitoring and evaluation of the environment[9].

Notwithstanding the above, Sudan lacks a coherent EWS framework. To help fill this gap, an integrated EWS called Sudan Climate Early Warning System (SCEWAS) was established through pilot partnership[10] instigated by Rainwatch-AfClix in June 2013[11]. This system aimed

4 United Nation Environmental Program (UNEP 2013) Governance for Peace over Natural Resources: A review of transitions in environmental governance across Africa as a resource for peace building and environmental management in Sudan, Pp.85.

5 FEWS NET (2011) A Climate Trend Analysis of Sudan. Informing Climate Change Adaptation Series, Fact Sheet 2011–307.Available online at [http://pubs.usgs.gov/fs/2011/3072/pdf/FS2011-3072.pdf] Last accessed on 21/11/2013.

6 Zakieldeen, S. A. (2009) Adaptation to climate change: a vulnerability assessment for Sudan. International Institute for Environment and Development. Gate Keeper Series: 142, Pp.20.

7 Shilenje, Z.W. (2013) Managing for Uncertain Climate Risk: Early Warning and Climate Communication in the Context of Sudan. Unpublished Dissertation, University of Reading.

8 Boyd, E., Cornforth, R. J., Lamb, P. J., Tarhule, A., Lélé, M. I., & Brouder, A. (2013) Building resilience to face recurring environmental crisis in African Sahel, *Nature Climate Change.* 3 (7). pp. 631-637. ISSN 1758-678X doi: 10.1038/nclimate1856.

9 Shilenje, Z.W. (2013) Managing for Uncertain Climate Risk: Early Warning and Climate Communication in the Context of Sudan. Unpublished dissertation, University of Reading.

10 These include: (Practical Action [PA], Sudan Meteorological Society (SUMS), Sudanese Environment Conservation Society (SECS), UN Environment Programme Sudan (UNEP) and

to provide a new seasonal monitoring capability for the monsoon season of 2013. Real-time knowledge of the evolving quality of the monsoon season has application to all stages of the development of Sudan's food crops. That knowledge should result in increased awareness and early warning of the likely food security situation following crop harvesting. So far, the SMA has made and transferred the needed rainfall and temperature measurements. The Rainwatch Platform uses Geographical Information System (GIS) to transform SMA rainfall and temperature measurements into information on relative monsoon season quality. The quality characterisations produced involve comparisons of season-to-date information with key long-term statistical representations extracted from 50 years of previous measurements (e.g. percentiles) and assessments are made against the evolution of previous similar and extreme years. Also, the progression of the new monsoon season is compared with the predictions of its development made by the SMA before the start of the monsoon.

Communities are at the heart of this initiative and AfClix is linking science to end-users through existing community-based organizations and networks, multi-stakeholder platforms and tailored innovative media platforms including community radio and SMS.

Sustainability and effectiveness

One of the greatest technical challenges to EWS is the relationship between monitoring, processing and transmission of weather and climate information to users[12] and this applies to Sudan as well. SCEWAS builds on existing institutions to ensure sustainability. Important areas to consider to enhance SCEWAS's sustainability include strengthening the technical capacity of community leaders; improving the integration of local knowledge with science; and developing existing communication networks within the pastoralist and farmer communities through established participatory methodologies.

Part of this grassroots dissemination is being facilitated through partnership with the NGO Practical Action, building upon a programme of "Knowledge Centres" (Practical Answers) aiming to provide technical inquiry and knowledge dissemination services to local communities.

One barrier to effective nationwide EWS scale up is coordination. Over 20 agencies and organisations are involved in supporting aspects of EWS in Sudan and there is little evidence of a systematic framework to direct, guide or coordinate these institutions. An open dialogue is needed in Sudan between donors, agencies and Government to arrive at a basic understanding of EWS, climate risk and the value of forecasting, monitoring and data provision for EWS.

A number of other challenges have impeded the development of an effective EWS in Sudan. There is a lack of specialist personnel available in the country along with limited training

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UN World Food Program (WFP)), (Ahfad University for Women (AUW)), and Government (Hydrological Research Centre – Sudan (HRC-Sudan), The Pastoral Strategic Action Plan (PASP) group, from the Range and General Pasture Directorate and the Ministry of Livestock, Fisheries and Rangelands, and the Ministry of Environment, Forestry and Physical Development (MEFPD)). Sudan Met Authority, Higher Councils for Civil Defence, Higher Council for Natural Environment Resources, and the Department for International Development (DfID), the Cooperative Institute for Mesoscale Meteorological Studies (CIMMS), University of Oklahoma [OU] and the National Centre for Atmospheric Science – Climate Directorate (NCAS Climate) and the Department of Geography and Environmental Sciences (GES) at the University of Reading (UoR).

11 AfClix (2013) Draft Report (v1) Partners Consultation Workshop Khartoum, 11-12 June 2013.

12 Tarhule, A., & Lamb, P. J. (2003) Climate research and seasonal forecasting for West Africans: Perceptions, dissemination, and use?. *Bulletin of the American Meteorological Society*, *84*(12), 1741-1759.

opportunities (there is no available BSc Meteorology in Sudan, although there are some postgraduate courses). Instruments used by the Sudan Meteorological Authority are mainly traditional though there have been some conversions to Automatic Weather Stations. Communication systems are fragmented due to weak Government support and limited resources devoted to monitoring and disseminating information. Finally there is a poor understanding of basic technical language and knowledge of EWS among the user community: "it cannot be assumed that research designed by climate scientists automatically yields results useful for people impacted by climate variability"[13].

Current research

SCEWAS plans to develop collaborative research with its partnership networks in Sudan. UNEP is working with the National Adaptation Plan of Action mapping out climate impacts. Building on this work FEWS NET has identified that potential research could include mapping of national livelihoods to show how people are make a living and developing key food insecurity indicators that include nutritional factors. Plans for the long-term future development of Rainwatch include moving towards the automatic transfer of data from automatic weather stations, for a wide-range of parameters, targeted for user-defined applications.

Research gaps

A fundamental barrier to EWS in Sudan is the impact of conflict and how that affects communities. The conflict displaces communities every three to four years, which is a major obstacle to the establishment of sustainable EWS interventions. In addition, political sensitivities dominate NGO access to communities. To-date there is little joined up thinking and if key organisations are expelled then a whole early warning component can be lost. While there is some institutional capacity for early warning in Sudan (e.g. FEWS NET) there is limited guidance for what action to take at the community level. This calls for more cross-sectoral work to identify the types of actions that can be taken by people on the ground.

Context specific information is important for communities to make informed decisions. This is a particular challenge in large states such as North Darfur. This requires investment in research on how to make information as geographically context specific as possible.

Another issue is related to bridging the gap between those who manage and distribute early warning information and end users. This centres around the question of how best to convert warning information it into a format (beyond websites) that can be easily understood by communities, enabling them to make informed decisions. Access to information is often limited for the most vulnerable in Sudan. It is also important to identify the risks of climate change and what early warning means to communities. Frequently, communities express a different set of priorities with regards to climate risk. For example communities may prioritise to invest in the education of girls as a climate risk strategy. This highlights the need to identify better what risk means for communities.

Finally, there is growing interest in telecommunications among development and humanitarian agencies, especially where populations are dispersed over large areas. In this case, are most vulnerable able to access mobile technology and is too much reliance placed on this mechanism of early warning information distribution.

Additional gaps include the following set of questions:

[13] Lamb, P. J., 1981: An attempt to address the question, "Are weather patterns changing?" for a nonspecialist audience. Bull. Amer. Meteor. Soc, 62, 376–380.

1. What information best supports effective EWS and how can this information help to reduce food security risks and strengthen the Sudan National Adaptation Plan of Action?
2. How are donors, the government and scientists engaging with communities? Do communities need monitoring information, or early warning for early action or forecasting?
3. What are the important risk-tradeoffs that people make in managing food-security assets? For example do farmers withhold food from sale if a drought is forecast for the next year, to capitalise on higher prices? Does this type of risk management strategy help farmers in Sudan to maximise their profits and minimise their losses? And what is the accuracy of seasonal forecasts that lead to farmers' withholding their crops?
4. How should the vital role of partnerships be enhanced to enable EWS at national and subnational levels in Sudan? This could include facilitating government, NGOs, CBOs and local residents in building dialogue around resilience, EWS and monitoring.
5. Recent scientific advances indicate some potential for seasonal prediction linked to seasonally delayed onsets and abrupt retreats of the Intertropical Front (ITF). Scientific challenges include: i) the decoupling of the August ITF latitude and rainfall from previous months; ii) the seasonal prediction potential of the latitudinal position of the April ITF; and iii) the driving control of the April ITF latitude and the influences on the persistence of the ITF latitude anomaly. This research can be done in Sudan using the historical and season-to-date daily rainfall data.

2.2 Kenya: Kenya's Drought Early Warning System (DEWS)

Background

Arid and Semi-Arid Lands (ASALs) are characterised by low, unreliable and poorly distributed rainfall, and are severely affected by drought. In Kenya, ASALs cover more than 89% of the country, are home to around 14 million people and approximately 70% of the national livestock herd[14]. While not all relevant trends are clear[15], the climate in the region is changing, and this is influencing the frequency of drought[16]. While droughts used to occur once every four or five years, drought has become a perennial risk for communities in the ASALs.

Following two or more poor rainy seasons in the Horn of Africa in 2010 and 2011, at least 13 million people were affected by chronic drought, most of them women and children. The number of food insecure people in rural Kenya reached 3.5 million[17], with the northern ASALs being the worst affected areas. In some locations, rates of global acute malnutrition (GAM) rose to twice the emergency thresholds (in Turkana North rates rose to 38%). Communities in the ASALs have a weaker foundation on which to respond to such disasters,

[14] Office of the Prime Minister (2012) National Policy for the Sustainable Development of Northern Kenya and other Arid Lands: 'Releasing our full potential'. Ministry of State for Development of Northern Kenya and Other Arid Lands. Sessional Paper No. 8 of 2012. Final, 11 October 2012.

[15] Including links between climate change and La Niña and El Nino Southern Oscillation (ENSO) patterns

[16] Oxfam (2011) Briefing on the Horn of Africa Drought: Climate change and future impacts on food security http://www.oxfam.org/sites/www.oxfam.org/files/briefing-hornofafrica-drought-climatechange-foodsecurity-020811.pdf

[17] DFID (2011) Business Case for Humanitarian Emergency Assistance 2011.

due to chronic underlying vulnerabilities linked to political, economic and social factors, which influence access to basic education, security, water, health services as well as mobility[18]. The deterioration in 2011 was not solely caused by poor rains and this chronic underlying vulnerability, but a range of compounding factors including high food prices, a lack of migration options given the widespread regional nature of the drought, and unpredictable food aid delivery. Although brought on by drought, a series of human factors turned the crisis into an emergency claiming the lives of approximately 50,000 to 100,000 people across the Horn of Africa region[19].

An Early Warning System to Manage Drought

The Kenya Drought Early Warning System (DEWS) was established in 1987. It is part of a wider drought management system aiming to trigger a timely response to drought by providing accurate and credible information to stakeholders. One of the obligations under the Government of Kenya's Arid Lands Resource Management Project (ALRMP) Development Credit Agreement with the World Bank was to institutionalise the drought management structures established by the ALRMP. In November 2011, the National Drought Management Authority (NDMA) was established as a statutory body with the mandate to 'establish mechanisms which ensure that drought does not result in emergencies, and that impacts of climate change are sufficiently mitigated'. The NDMA spearheads Kenya's preparation, risk-reduction and drought response.

Kenya's EWS relies on the collection and monitoring of data by a sample of communities. Each month data is analysed and published in a drought monitoring bulletin by NDMA offices in 23 arid and semi-arid counties. These monthly bulletins confirm the specific stage of drought in each county (i.e. normal, alert, alarm, emergency or recovery) and whether the situation is worsening or improving. They also recommend actions to be taken in response at each drought stage. Any stage other than normal may trigger a rapid assessment by county authorities to fine-tune needs on the ground[20]. Drought monitoring is carried out against a common set of indicators: 1) Environmental indicators (rainfall, forage, and water sources); 2) Rural economy indicators (food availability, livestock and crop diseases, livestock and crop production); 3) Human welfare indicators (food consumption, livestock and crop prices, and the nutritional status of children under five years old)[20].

Sustainability and Effectiveness

The sustainability of the drought management system has been helped by the institutionalisation of the EWS through the establishment of the NDMA. Formal coordination structures including District/County Steering Groups established in the 1990s, provided an effective collaboration and coordination system of community, district and national-level institutions[18]. Sustained financial and technical support from individuals and development partners, particularly the European Union, has provided the important continuity that has enabled DEWS to improve sustainable outcomes for drought affected communities in Kenya over the past 30 years[21].

Another key element of ensuring EWS sustainability is political buy in and ownership. In 2013, management of drought in Kenya was elevated onto the political agenda when the government endorsed a medium term plan (MTP) (developed by the Ending Drought Emergencies Thematic Group), which integrates ASAL issues into mainstream planning and budgeting for the first time, under the Kenya Vision 2030 development blueprint. However,

18 Personal communication: Izzy Birch, Technical Advisor National Drought Management Authority, Kenya.
19 Oxfam and Save the Children (2012) A Dangerous Delay
20 NDMA (2013) The Drought Early Warning System in Kenya. NDMA Brief 2.
21 NDMA (2013) Learning from the Pioneers: Workshop Report.

the ASAL Cabinet Sub-Committee, recently endorsed by Parliament, will be a crucial mechanism for ensuring that sectors deliver according to the MTP. Also in 2013, the NDMA was relocated to the Ministry of Devolution and Planning and the government continued to develop a National Drought Contingency Fund (NDCF) aimed at supporting early mitigation efforts for effective drought cycle management. In addition to the World Bank credit conditionality requesting the institutionalisation of structures established by the ALRMP, the continued scale-up of the DEWS has been influenced by evidence generated from earlier experience identifying the importance of long-term implementation periods for projects in the ASALs to have meaningful impact on the most vulnerable populations. The EWS now covers 23 arid and semi-arid counties[18].

As Kenya continues to make the transition towards a devolved system of governance, new county-level NDMA offices, and new budgets and plans such as the county development plans and National Climate Change Action Plan (2013 to 2017)[22], point to uncertainty about how the NDMA will coordinate emerging structures and processes to maximise improved drought management. While activities are underway to address other barriers, the DEWS has also experienced and learnt from inefficiencies; language-barriers and illiteracy, which have prevented the reach of some information to illiterate individuals, or those lacking an understanding of English and; ineffective media communication channels to disseminate messages to the widest audience. While it is often the non-technological issues that are more important for the effectiveness of the EWS, a lack of funds and technical capacity to maximise use of advanced technology has also been a limiting factor in the past, but barriers are now being addressed[21].

Effective EWSs deliver informative and advisory outcomes at a multitude of levels, supporting community, district and national-level institutions. At community level, the Kenya DEWS has shown that capturing existing local knowledge of changing trends and patterns as an input for the EWS leads to successful outcomes, but the more challenging yet crucial stage is ensuring outputs (such as risk maps and simplified data) are communicated back to the community. The establishment and strengthening of the NDMA is likely to improve the country's ability to manage drought significantly, but ensuring principles of resilience underpin all processes will be fundamental to its long-term effectiveness.

The multi-level coordination structure has been central to the successful outcomes delivered through the Kenya DEWS. However, action will still be weak until there is a permanent availability of contingency finance to ensure quality response to the earliest signs of drought[23]. The operationalization of the NDCF will help achieve sustained access to finance, including enhanced decision-making and resource-allocation. This is vital to catalyse the timely and appropriate action required for early response (not only early warning) in advance of future droughts[18]. Finally, local knowledge of drought hazards and vulnerabilities has improved due to the active participation of communities. The institutionalisation of DEWS has enabled better coordination between communities and county level institutions, enhanced the quality of the contingency planning system (which has recently been standardised so information on resource allocation and implementation can be monitored almost in real time), empowered communities to mobilise local resources in response to emerging disasters, and improved capacity for communities to use EWS information for decision making[24].

22 Government of Kenya (2013) National Climate Change Action Plan (NCCAP) 2013 - 2017

23 Oduor, J., Swift, J., and Birch, I., (2013) The Evolution of Kenya's Drought Management System. Draft Chapter . Unpublished.

24 Ministry for the Development of Northern Kenya and Other Arid Lands (2012), Presentation at the Second Africa Asia Drought Adaptation Forum (AADF 2012) about the National Drought Management Authority. See:

Current research

Research, by multiple agencies, into the 2008 to 2011 drought in Kenya identified inefficiencies in the way national and international institutions responded to the crisis and the role of the NDMA in coordinating the implementation of improved, integrated approaches to drought management. This included national actions and regional coordination under the Intergovernmental Agency on Development's (IGAD) Regional Platform for Drought Disaster Resilience and Sustainability Initiative (IDDRSI)[25]. In addition, research is currently underway to assess how donor pledges made in response to the 2011 crisis have been met[26]. New projects are being undertaken to try to address some of the inefficiencies identified, including the recent launch (August 2013) of colour coded flags to provide simple visual messages to communities on the status of drought, as well as the establishment of Drought Ambassadors' Clubs in primary schools to aid preparedness activities at community level. The International Livestock Research Institute (ILRI) has also carried out a thorough review of the EWS and recommendations are now being discussed with the government for further improvements[18].

Research gaps

Emphasis needs to be placed on *early response* to drought, not just on *early warnings*[18]*.* The high-level meeting on national drought policy, which took place in Geneva from 11 to 15 March 2013, highlighted that more research needs to be done to support countries to prepare for and respond to drought, as well as improving early warnings systems. While Kenya has successfully scaled-up a small, community-level drought early warning system into a statutory institution with high political leadership attached to the process, many countries still do not have effective drought monitoring and risk management systems in place, and therefore research is needed to support countries in the development of frameworks to manage drought risks through an integrated approach.

For Kenya, drought continues to threaten the livelihoods of millions across the ASALs and amid new commitments to review the way the international, regional and national humanitarian and development communities respond to drought, the pace at which preparedness activities are being implemented on the ground is still slow. Although research is being undertaken to assess whether donor pledges made in response to the 2011 crisis resulted in action, preliminary findings suggest more has been done to support regional-level coordination processes than in supporting real activities at community level to build preparedness for, and resilience to, subsequent droughts.

Additional research questions for the academic community might therefore be how new research can further support the rapid distribution of finance for effective resilience-building measures at community, county and national level; and how can the development and humanitarian community contribute to meeting the demand for resilience-building on the ground, without being hindered by the inefficiencies characteristic of donor and recipient institutions and regional processes?

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http://www.undp.org/content/dam/undp/library/Environment%20and%20Energy/sustainable%20land%20management/AADAF2/kenya.pdf

25 IGAD (2013) communique of the general assembly igad platform for drought disaster resilience and sustainability in the horn of africa http://igad.int/attachments/572_COMMUNIQUE_OF_THE_FIRST_GA_OF_IDDRSI_PLATFORM_23FEB2013.pdf

26 REGLAP (2013) From Commitment to Action: Are donors meeting their pledges to build resilience in the HoA? Draft Report by Agnes Atyang and Sarah Standley. Unpublished.

Most importantly, unless finance is invested in strengthening crucial enabling conditions for effective EWSs, basic education, security, water, health services as well as roads, communities will always be faced with barriers that limit their ability to fully react to the information provided by early warning systems.

2.3 Uganda: The Karamoja Drought Early Warning System (DEWS)

Background

The Karamoja sub-region in north-east Uganda is a pastoralist area. Livestock is central to livelihood sustainability and households are highly dependent on climate-sensitive resources including pasture and water. Drought is the most frequently occurring natural catastrophe in the Karamoja region of Uganda. At least 13 million people were affected across the Horn of Africa by the 2010/2011 chronic drought and the Karamoja region was badly affected.

The Karamoja Drought Early Warning System (DEWS) was established in 2008 under the Drought Preparedness Consortium led by DanChurchAid (DCA) and supported by the European Commission's Humanitarian Aid and Civil Protection Office (ECHO)[27]. Implemented by the Agency for Technical Cooperation and Development (ACTED) in collaboration with local and national governments, international organisations and United Nations (UN) agencies, DEWS began as a pilot project inspired by the Kenyan model. It is now used to build resilience to drought in communities across seven districts of the Karamoja sub-region[27]. The system is based on data collection and analysis, taken from a representative sample of 10 households per parish (75 parishes in total are sampled) recording and communicating data on key indicators through a variety of means, including mobile phones. Once the data is collated, it is analysed by District Heads of Department with oversight from line ministries, and each month, drought bulletins are produced for the seven districts of Karamoja. Results are used to provide months-in-advance predictions on drought risks and localised impacts. The information in the drought bulletin is translated into recommendations that are communicated to communities and development partners through several means, including radio and drama performances. Livelihood groups are provided with information so that community preparedness measures can be initiated or strengthened[28].

Sustainability and Effectiveness

The DEWS is fully managed by local government officials and designed to ensure its sustainability. However, technical and financial support from ACTED, the major implementing agency, is still crucial to system function. In 2012, ACTED and DCA developed a DEWS Exit Strategy which aims at a phased handover to the government, both in terms of the financing of DEWS, but also in terms of independent technical management of DEWS activities. ACTED is advocating for the DEWS to be fully funded and managed by the Government of Uganda by 2016/2017. ACTED will continue to support a hand-over process for the next five years. Central to this strategy will be to lobby relevant ministries to include DEWS in their annual budgets. Once ownership has been transferred, DEWS could be included as an indicator for performance evaluation at district level, which will facilitate effective local uses of the system.

A 2012 review of the DEWS by ACTED[27] presented a number of recommendations for improving EWS, and several of these recommendations have already been implemented.

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27 ACTED (2013) Study on lessons learnt from drought early warning systems in Uganda and Kenya.

28 ACTED (2013) Karamoja Drought Early Warning System.

This includes the central incorporation of EWS in the National Disaster Preparedness Policy developed by the Office of the Prime Minister (since 2012), and national government advocacy for DEWS to be included in the national budgeting and planning system. Additionally, ACTED is advocating for DEWS to be covered by the upcoming World Bank Pastoral Resilience Project and for the scaling up of DEWS to the Teso sub-region of Eastern Uganda, which is affected by both drought and flooding. The DEWS methodology is in line with local government structures and can be easily embedded into any district in Uganda. Similarly, the indicators can be adapted to fit the context and priorities of each district (which might be to respond to other hazards, not just drought), thereby facilitating the potential for scale-up.

The ACTED/DCA consortium has needed to overcome a variety of barriers to scaling-up the Karamoja DEWS. Firstly, the accuracy and timeliness of the DEWS monitoring and warning service has been limited by late issuing of monthly bulletins. Particular inefficiencies occur in the review-process at national government (ministry) level. The reach of information issued by DEWS has not been maximised due to limits of available technologies. Similarly, radio messages have been far-reaching but low rates of radio ownership among the most vulnerable groups have limited impact. Infrastructural barriers have also been identified as a risk to the effectiveness of DEWS, because infrastructure such as roads, water, education health services, and security, provide the enabling conditions required for communities to modify or adopt new livelihood strategies. At the national level, corruption has delayed the hand-over of DEWS from ACTED/DCA to the Ugandan government[28]. At a smaller-scale, the scale-up of DEWS into new districts, one of the main challenges was ensuring parish chiefs would agree to collect data without financial compensation, and also ensuring a designated focal person was selected and carried out their duties.

Data collected from 750 households for the ACTED (2012) study shows that DEWS has enhanced local knowledge of drought hazards and vulnerabilities[28]: Radio messages with DEWS recommendations have been heard by up to 300,000 people. Drought bulletins are used by communities to initiate preparedness measures (e.g. early planting, construction of grain storage facilities); used by local government to guide interventions (e.g. vaccination campaigns); used by NGOs and development and donor agencies to guide interventions and project planning; and used by national government to initiate rapid assessments (e.g. the rapid food security assessment undertaken in August 2013 together with Makarere University, the World Food Programme and the Food and Agriculture Organization (FAO)).

Communities are very active in the data collection and analysis processes of DEWS, hence knowledge and capacities related to hazards is good. DEWS could do more to capture existing local knowledge of changing trends and patterns at the data input level. At the output level, DEWS could increase the availability of risk maps and data to communities for enhanced drought preparedness and response.

Challenges to EWS effectiveness

For an EWS to be effective, it should be integrated in relevant government policies, plans and budgets[28]. This can be facilitated by handing-over ownership and management of EWS to government agencies after successful establishment. Similarly, integrating performance indicators relating to EWS at district government level can enhance the effectiveness of DEWS, by enhancing the capacity for the national government to formally oversee the production of drought bulletins. Performance indicators also create incentives for districts to implement DEWS.

A number of issues have contributed to delays in the DEWS. Data collection can be delayed by poor weather and rough terrain, and logistical challenges have impeded ACTED's ability to collect questionnaires from the field. Inertia, which is common in government structures,

can create delays in the dissemination of information to those that need it most, and busy schedules of government officials also prevent timely feedback on bulletins[28].

A good practice note compiled by all stakeholders of DEWS in May 2011 suggests the following practical success factors[29]:

- Keep a list of indicators short for ease of collection and analysis
- Keep representative household numbers low to enhance quality of data collected
- Apply new and innovative technologies
- Ensure integration of EWS into local government
- Involve local government and communities in training from the beginning
- Harmonize EWS into existing disaster risk reduction (DRR) and other risk analysis mechanisms and systems
- Ensure a data quality control system is implemented concurrently with the data collection system
- Build and strengthen partnerships
- Ensure the acquisition of baseline data
- Work within the limits of the resources available
- Use existing chains of communication where possible
- Involve all levels and all sectors
- Build accountability to secure role delivery and finally
- Ensure roles and responsibilities are distributed clearly to individual actors

Current research

ACTED has planned two comprehensive reviews of DEWS in the coming two years, as well as two reviews of the indicators and the early warning phase classification thresholds. In addition, ACTED and FAO are also re-structuring the DEWS data flow system to a centralized database, which will provide raw data through an online map prior to bulletin production. This will ensure that early warnings are produced even if the bulletins are delayed. To overcome the delayed reviewing of monthly drought bulletins at ministry level, ACTED are trialling a new strategy, to identify more junior members of staff within each ministry to carry out the review of recommendations. This should enhance the pace of communicating early warning messages to the local level.

Research gaps

Since the Horn of Africa drought emergency in 2011, the international community including government, UN and NGOs have committed to reducing underlying causes of vulnerability well in-advance of crises occurring[30]. To enhance EWS, the development and humanitarian communities need to be supported in their ability to plan integrated, long-term and participatory approaches[27]. Further research could support the Karamoja DEWS to respond to the needs of the humanitarian and development community.

According to ACTED, one major research priority will be research into the contingency mechanisms of governments and of organizations such as WFP, which are mandated to respond to disasters/emergencies. It is worth investigating how such contingency mechanisms can support the DEWS and support improved rapid assessments and early action in response to bulletin information.

29 ACTED, ECHO, DanChurchAid et al., (2011). Good practices from the drought EWS in Karamoja, Uganda. For DCM partners meeting, Addis Ababa, 16th & 17th May 2011.

30 United Nations (2011) Ending drought emergencies: A commitment to sustainable solutions. 9th September 2011. http://www.unicnairobi.org/horn_africasummit2011.asp

Research can enhance understanding of how to improve the efficiency of higher-level processes (such as the hand-over of EWS to national government ministries) as well as assessing how to address community level barriers (such as the limits to access and use of technology).

SECTION 3

Case studies from West Africa

3.1 Burkina Faso: Drought Early Warning with the Household Economy Approach

Background

Recurrent drought is a fact of life in the Sahel, ranging from localised rainfall deficits which occur every year, through to occasional widespread severe events, the most recent of which (2011) affected 18 million people across the region. There are 10.3 million people in the Sahel who are facing food shortages this year (2013) with 4.5 million children under 5 at high risk of acute malnutrition[31].

In Burkina Faso, where 80% of 17 million inhabitants rely on subsistence farming, poor yields in 2011 signalled an impending food emergency. Faced with an urgent need to estimate the numbers of people that would be affected and to identify the most vulnerable groups for the delivery of aid, Burkina Faso's government took the lead in applying the Household Economy Approach (HEA) to provide vital indicators to manage the food crisis and target assistance.

The Household Economy Approach (HEA) is a framework for analysing how people obtain food, non-food goods and services, and how they might respond to changes in their external environment caused for example by drought or a rise in food prices. It provides indicators at household level of developing food emergencies, allowing early warning and earlier and more effectively targeted action. As a first step in the HEA, a baseline study is carried out in each livelihood zone, to develop as full a picture as possible of the livelihood system. Then three times a year monitoring data on the key parameters are updated, the changes are applied to the baseline, using a spread sheet, and estimates are made of outcomes at household level including a quantitative estimate of needs. The estimates are made by analysts, who need training and capacity building to do this well.
The HEA was developed by Save the Children in the early 1990s and first used by them in the Sahel (in Niger) in 2007. Since then, use of the HEA has been extended to seven West African countries by SCF and its partners under the programme HEA-Sahel. In Burkina Faso, where Oxfam is Lead agency for the HEA Sahel consortium (SCF and partners), baseline studies in two livelihood zones were carried out in 2010 to 2011 paving the way, in 2012, for studies to be carried out across the entire country (nine livelihoods zones). This scale up was led by the EWS office at the Ministry of Agriculture, with broad support of humanitarian actors, development agencies and donors.

The analysis revealed that 2.8 million people (about 20% of the population) would potentially suffer food shortages in 2012. Vulnerable families were found to often be those with least access to farmland and most reliant on casual work and markets, where price rises can put staple foods beyond their reach, providing evidence that increasing food production is not,

31 A Road Map For The Future Mapping Rural Livelihoods To Manage Food Crisis: The Unique Experience Of Burkina Faso, by Claudia Delpero International Communications Consultant 31 August 2013 SCF With the financial support of ECHO – European Commission

on its own, sufficient to end food insecurity in Burkina Faso. A response plan worth over £142 million was developed and implemented by government departments at national and local level, with support from international organisations and NGOs[31].

Sustainability and effectiveness

The Government in Burkina Faso has given high level support to use of the HEA and integrated it fully into its Early Warning system and related decision making processes. Baseline data has been collected for all the nine livelihood zones used by FEWS NET and the results of Outcome Analyses, together with data already collected by the EWS, prompt and inform response plans by the National Council for Food Security (a coordinating body including some 10 ministries). This institutionalisation process creates favourable technical and financial conditions, for sustainable use of the HEA within Burkina Faso's EWS.

By taking the lead the government in Burkina Faso has been able to coordinate finance for the baseline studies (cost £105,000[32]) which were funded by the Ministry of Agriculture with support from Oxfam, the World Food Programme and ECHO. Future costs will be lower, mostly for updates and meetings, and will be integrated into funding for the EWS as a whole.

Further evidence of sustainability of the HEA as part of EWS and early response in Burkina Faso can be found in a broad consensus obtained amongst food security operators and in the good availability of human resources. More than 14 NGOs in Burkina Faso use the results of the HEA to target their interventions and a core network, of at least 200 people (all Burkinabé), are trained and able to manage the tool. Some donors (ECHO in particular) recommend use of HEA as an essential element of humanitarian response analysis and NGOs are increasingly putting budget lines for HEA in their project proposals. HEA threshold indicators were integrated into the "Cadre Harmonisé" (Harmonised Framework), an instrument for analysis of vulnerability at regional level by CILSS (Comité Inter-états de Lutte contre la Sécheresse au Sahel), in January 2013.

As with any EWS, cost is one of the major challenges to sustainability. Currently Outcome Analysis is completed three times a year to fit in with the national and regional CILSS EWS seasonal assessments. Technical quality needs to be maintained through adequate training and supervision. While in Burkina Faso the government has been largely successfully so far in raising the funds required, the same cannot be said for the government in Mali, faced with a political crisis and armed conflict in the North since early 2012.
Short term funding from humanitarian agencies and in particular from ECHO has financed most of the development of the HEA in the Sahel. The Government of Burkina Faso and its partners have begun to diversify funding sources but these are still for the most part short term, which is a concern for staff stability/retention. Working with governments and building capacity to use the HEA requires longer term funds to be available. Response funding mechanisms also need to be adapted to the information provided by the HEA.
Acceptability of the results provided by the HEA is another major challenge. Organisations as diverse as FEWS NET, WFP, FAO and NGOs as well as the Government have to find the information they need from HEA and be confident in the findings. Not all organisations are always willing to accept the results, even if they have been involved at all stages. This can happen when for example, the HEA indicates a less severe crisis than the one the organisation has previously declared. The WFP uses elements of the HEA in their Emergency Food Security Assessment (EFSA) but still need to collect specific quantitative data using their own methodology to meet internal monitoring and evaluation requirements. The challenge of reaching consensus is even more complex at regional levels (within the Cadre Harmonisé). In Burkina the experience has been that when the crisis is serious (2012)

[32] 82 million FCFA

it is easier to reach consensus than in years such as 2013, where there is no immediate crisis but on-going high levels of food insecurity.
When all required data is collected, the HEA is able to estimate the numbers of people affected, and provide information about the criteria for targeting and the timing and amount of assistance. It requires trained analysts to do this but is more transparent and relies less on expert interpretation than the classic EWS (SAP) and the Cadre Harmonisé at CILSS. Moreover the HEA can identify targets scaled down to household level. The fact that in Burkina Faso data and outcome analyses are routinely updated three times a year means that the Government receives prompt early warning.

The HEA is only one component of an effective EWS and is itself not perfect, with scope remaining for improvement. Data on key parameters is not always collected by the existing information systems and may not be available for inclusion in the analysis of outcomes. This includes data on migration, money transfers from abroad, humanitarian efforts underway and the influence of urban areas.
The analysis of livelihoods needs to be regular even in years with no specific difficulties to help to ensure that scenarios are reliable. As with all EWS, political and personal interests may affect the data collection process and undermine the credibility of the findings (as is the case in North Mali following the armed conflict).

Current research

OXFAM in Burkina plans to devote the period 2013 to 2017 to developing baseline studies for urban areas, starting with Ouagadougou to improve understanding of urban livelihoods and household vulnerability. They are also undertaking a study into HEA and gender.

CILSS is looking at methods to evaluate agricultural production. Official government agricultural data are a key parameter used by the national and regional EW systems, but are not generally considered reliable.

In related research, SCF has developed a pilot HEA Atlas for the seven countries where HEA has been used. Chatham House has carried out research into how crises are managed, to identify barriers to good decision making. The WFP is undertaking a Resilience and Food Security Study in Mali looking back at SAP results since 2008 and categorising communes as either more or less resilient according to the number of times they were classed as 'in difficulty'. WFP is also working with community representatives in the Koulikoro region to understand more about their livelihoods and define appropriate responses. The EU is undertaking a study of value chains in Mali, looking at which ones are critical to the resilience of rural populations and where they need to be strengthened.

Research gaps

Further research could incorporate data on migration, money transfers and on-going humanitarian actions, and investigate whether the absence of this data significantly affects Outcome Analyses. A better understanding of the impacts on children and the level of revenues associated with children (child labour, artisanal mining or illegal activities) would also be useful, as would research to investigate whether the nine current livelihood zones in Burkina are still appropriate or whether a more detailed breakdown of livelihood zones is required.

Research to ground-truth the results of Outcome Analyses would be a useful cross-check on the accuracy of predictions and help to improve them. Research could look at who was included or excluded by the predictions and whether the response on the ground matches the criteria provided by the national analysis and, if there are differences, what is the reason. The analysis of the household food security situation and nutrition outcomes tends to be done separately. Research could help to improve understanding about the interactions.

HEA is only one of a range of tools for Early Warning, and research is needed to investigate more deeply the co-relation and complementarity between the different methods and tools, and opportunities for greater integration.

Research into poverty trends, using information on structurally vulnerable households from the HEA could give useful insights into policies and actions to manage food crises. For example, which policies make some social groups more resilient to food crises than others? This research should take a partnership/multi-stakeholder approach, including a regional university or an institution such as Agrhymet (CILSS) which is responsible for the "cadre harmonise".

3.2 Niger: Niger's Drought Early Warning System (DEWS)

Background

Food insecurity is a daily reality in Niger, one of the poorest countries in the world[33] (current GDP per capita USD $383). Droughts, floods, long hunger gaps and diseases have become the norm. Those who are chronically poor struggle to cope effectively with these shocks. Typically, more than three million people are permanently in a precarious position. Around two million people still go to bed hungry every day with 300,000 to 400,000 children suffering malnutrition.

Living with permanent fragility, Niger has developed one of the Sahel's most sophisticated government early warning systems (EWS) for potential food security risks or crises, known as the Système d'Alerte Précoce (SAP). This EWS is supported by a crisis management office (le Cellule de Crise). Both offices are in close proximity to the premier's own office, which facilitates regular access to the top levels of government.

The strength of Niger's EWS lies in both the breadth of local data collected and in its institutional governance and management. Data is collected by officials, departments and agencies with local-level engagement and regularly reported to the central government. The EWS and Cellule de Crise staff are supported by technical staff in key ministries who ensure effective early warning and crisis response happens at local level. The pattern of interdepartmental coordination is replicated through regional and sub-regional crisis prevention and management committees.

Despite this comprehensive reporting system, delays significantly diminish the usefulness and value of EWS data for many applications, including monitoring of dry spells, heavy rain events and flooding, and irrigation planning and management. Since 2011, monitoring of the evolving rainy season in real-time has been accomplished by the Rainwatch[34] platform, an automated rainfall monitoring system that ingests year-to-date station data on a daily basis. Real-time outputs are easy-to-read showing seasonal evolution with comparisons to analogue years at the same location. Coupling of Rainwatch with the boundary organization, AfClix[35] (Africa Climate Exchange) from 2013 onwards is helping to integrate the expertise

33 http://data.worldbank.org/indicator/NY.GDP.PCAP.CD/countries/1W?display=default (accessed 19-11-13)

34 Tarhule, A., Z. Saley-Bana, and P. J. Lamb, 2009: Rainwatch: A prototype GIS for rainfall monitoring in West Africa. Bull. Amer. Meteor. Soc, 90, 1607–1614

35 Boyd, E., R. J. Cornforth, P. J. Lamb, A. Tarhule, M. I. Lélé and A. Brouder, 2013: Building resilience to face recurring environmental crisis in African Sahel. Nature Publishing Group, 1–7

and actions of relevant institutions, agencies, and stakeholders to broker ground-based dialogue and promote resilience in Niger.

Sustainability and Effectiveness

Funded by the EU, the Niger EWS is underpinned by a public service noted regionally for its technical capacity and solid implantation at local level[36]. The strong local administration has ensured continuity of local data collection despite periodic political upheavals. The latest Rainwatch technology will be fully transferred to Niger Met Services in 2014, and as Professor Abdelkrim Ben Mohamed indicated (Special Advisor to President for Water and Environmental Issues, 15 October, 2011), "I am sure Rainwatch will play an important role in the future of the region given the valuable insight it gave us during this rainy season".

Scaling up the successes of the Niger EWS at a regional scale requires a common approach for monitoring, sharing data, using agreed methodologies for assessments of vulnerability, and real-time monitoring of food security and malnutrition risks. The Rainwatch-AfClix framework[13] bridges the gulf between the availability of information and ability of vulnerable groups to act on that information and now extends to Senegal, Mali, Burkina Faso and Niger with new pilots in 2014 in Sudan and Ethiopia. Embedding the Rainwatch/AfClix platform nationally in Niger and subsequently in a regional body such as Comité permanent Inter-Etats de Lutte contre la Sécheresse (CILSS), would contribute to the common approach needed as CILSS acts as a hub for the collection of data and the mobilization of West African government efforts to counter crises.

Political leadership is critical to enhancing an EWS as a tool and extending its reach. A key barrier is the sustainability of an open and honest culture that recognises problems before they become crises. The current conflict about how to measure food security also obstructs upscaling. There are notable differences between FEWS NET and most other agencies and NGOs over how data should be assessed and in particular over the conclusions about risk and need that should be deduced. For example, during the 2012 crisis, FEWS NET were more confident than most other agencies about the ability of West African market supply and demand mechanisms to respond to local harvest shortfalls. Consolidating the metrics would better enable institutional capacity for processing the volume of relevant agro-meteorological information required in near real-time. It would also help address the current lack of trust in data and analyses by donors which prohibits timely mobilisation of aid and open dialogue. Additional barriers to scaling up include limited technical competence, poor organisation, siloed ministries, threats of further instability, institutional structures with conflicting institutional motivations, and NGOs choosing their own project locations rather than dove-tailing into a national strategy.

The crisis of 2011to 2012 severely tested Niger's EWS, and the supporting Rainwatch monitoring platform. However, through the EWS' relatively good organisation and through the timely nature of the reporting by Rainwatch[34] at 10-day intervals, early warning of the poorly evolving monsoon rainy season and likely shortfalls in food supplies were delivered. This monitoring long foreshadowed the end-of-season rainfall total for Niamey barely exceeding the 10th percentile and showed that the monsoon was "irrecoverable" for food production by the typical seasonal peak (around August 15). Trust in the Niger EWS system meant that donors felt able to voice strong early backing: the capacity of the Niger government and its external partners "was substantially helped by the existence of a well-organized EWS"[36]. This was in stark contrast to the 2011 food crisis in the Greater Horn of Africa, where an absence of effective measures to anticipate and manage acute rainfall

[36] Translating Famine Early Warning into Early Action: A Sahel case study. Paul Melly, Chatham House, April 2013.

deficiency[37][38] contributed to a situation where, according to estimates, 50,000 to 100,000 died with billions of dollars wasted.[39] In August 2011, several international figures acknowledged Rainwatch's value[40].

There remain however a number of barriers to overall EWS effectiveness:

1) Access and availability: The lack of a common approach for monitoring, sharing data and using agreed methodologies for assessment of vulnerability and real-time monitoring of food security and malnutrition risk critically hampers timely and efficient response from national governments and international partners.
2) Capacity and funding: Lack of capacity (infrastructure and technical) and ineffective management of information slows government receipt and subsequent analysis; lack of trust in credibility and reliability of figures generated[37]; and lack of objectivity.
3) Willingness to engage: Strong political leadership is needed to navigate government reluctance to recognise a problem and request assistance
4) Data management: Poor data management processes have resulted in limited stakeholder participation, a lack of data uniformity, and limited integration of relevant data.

Current research

Building on the Rainwatch-AfClix framework, a series of Drought Early Warning (DEW) Case Studies are underway in countries across the African Sahel. This will help establish a systematic, transparent and comprehensive DEWS for humanitarian, development and policy planning purposes that can be embedded in national strategies and regional frameworks e.g. CILSS. The DEWS will be built on the existing Rainwatch monitoring platform[41] and will focus on how weather information can be integrated with other vulnerabilities and stresses to support early warning, importantly including in-season evaluation of seasonal forecasts.

Since 2012, a range of international agencies and CILSS have been engaged in detailed discussions over the development of a common approach, and provisional agreement has been achieved on a map of food security risk across the region. However, some significant differences of approach are yet to be resolved. Key UN humanitarian agencies are jointly developing a package of advice for all nine existing member states of CILSS on how to measure and interpret data on a common basis. FEWS NET are continuing to examine the functioning of local household livelihoods, the movement of goods, markets in food, and how these fluctuate according to seasonal patterns of agricultural output.

Research gaps

37 Joint Agency Briefing Paper Save the Children-Oxfam. A Dangerous Delay: The cost of late response to early warnings in the 2011 drought in the Horn of Africa, 18 January 2012.

38 UNOCHA (http:www.unocha.org), August 2012

39 New York Times January 19, 2012. http://www.nytimes.com/2012/01/19/world/africa/report-finds-slow-response-to-east-africa-famine.html (2012)

40 Including in the United States (Ms. Mary Glackin, Deputy Under Secretary of Commerce; Mr. Craig McLean, Acting Assistant Administrator for Oceanic and Atmospheric Research, National Oceanic and Atmospheric Administration) and the United Kingdom (Professor Julia Slingo, Met Office Chief Scientist).

41 Cornforth, R. J., Boyd E., and Lamb P. J. (2013). "Case Study 5: Watching the rains to build resilience in the African Sahel", by in "Using Science for Disaster Risk Reduction" Report of the United Nations Office for Disaster Risk Reduction (UNISDR) Scientific and Technical Advisory Group, launched at the UNISDR Global platform in June 2013.

1) Research to ensure that scientific data is accurate, reliable, accessible, understandable and context relevant. Weather/data parameters being measured and the information being generated should be relevant to the needs of smallholder farmers, pastoralist communities and development planners. There is a need to correlate how parameters are measured so that there is consistency between scientists and communities on what and how to measure. There is a need to integrate development and humanitarian issues in scientific research at the outset, to ensure science is demand-driven.
2) Research to improve the presentation, communication and dissemination of scientific information. How to enable transformation of information into actionable knowledge e.g. through language, symbols, or references that are understood by smallholder farmers and pastoralists (including those who are illiterate).
3) Development of a fully integrated DEWS "package": To achieve impact at scale, weather/climate data is most effective as part of a DEWS, that includes diverse stakeholders and is based on an understanding of how weather information can be integrated with other vulnerabilities and stresses to support early warning.
4) Improved monitoring, instrumentation, and data associated with early warning systems: Deficiencies in rainfall data management and dissemination stand in stark contrast to impressive advancements in seasonal rainfall forecasting.
5) Contextual climate/weather data is more useful to smallholder farmers when combined with other information e.g. on crop types, planting techniques, yield predictions and market prices. Climate information requires long-term monitoring to establish the "climate" and key deviations.
6) Two-way flows of information: It is important to ensure potential beneficiaries are involved in the design of research activities (either communities or development planners), and vice versa, to assist humanitarian and development practitioners to secure scientific expertise when developing technical preparedness, resilience or adaptation interventions.
7) Demonstrating impact: The quality and robustness of scientific research must be matched by the quality and robustness of impact M&E. This is an area for transdisciplinary collaboration, NGO's can help scientists to identify appropriate impact outcomes and indicators and scientists can help NGO's develop more valid and reliable monitoring and measuring systems and methodologies. Research can quantify and evaluate the impact of early warning information on the livelihoods of drought-prone communities before/during/after rainy seasons, in turn bringing new questions to the climate research table in the "operations-to-research" mode.

SECTION 4

Case studies from Southern Africa

4.1 Zimbabwe: Zimbabwe's Drought Early Warning System (DEWS)

Background

Drought is the most common hazard in Zimbabwe and accounts for six out of ten major disasters between 1982 and 2012. Drought in Zimbabwe is linked to the warm El-Nino-Southern Oscillation (ENSO) in the Pacific Ocean, which has worsened since the mid-1980s. In Zimbabwe, drought occurs countrywide almost once every two years, but it is most chronic in the semi-arid agro-ecological regions of Zimbabwe.

According to the 2012 Zimbabwe Vulnerability Assessment Report the level of vulnerability in semi-arid and arid agro-ecological regions is high. During the period 1992 to 2012 over six million Zimbabweans were affected by drought in Matebeleland South, in Gwanda, Bulilima, Mangwe, Matopo, Insiza South and Beitbridge. Drivers of disasters triggered by droughts include: poverty and rural vulnerability; increasing water demand due to urbanization, poor soil and water management; and climate variability and change.

Zimbabwe's National Early Warning Unit (NEWU) located in the Ministry of Agriculture and Lands is the focal point for information regarding crop forecasting for all agricultural sub sectors and for drought monitoring. NEWU works in collaboration with the Drought Mitigation Centre in the Met Office to determine the likelihood of a drought. The EWS is comprised of localized sub-weather stations equipped with rain gauges, barometers, wind vanes, thermometers and computers for weather modeling and analysis. The sub weather stations are located in all the 10 provinces in Zimbabwe (sub-national) which are managed by the Agriculture Extension service (Agritex) and supervised by the Met Office. The system operates 24 hours a day with continuous monitoring using hazard precursors and parameters. The information generated by the system is mainly short-term agro-meteorological forecasts over a period of 30 days focusing on wind direction, wind speed, rainfall, temperatures and an analysis of how various crops will perform under the conditions forecasted. Risk assessments are then carried out by the Drought Mitigation Centre leading to the prioritisation of mitigation actions, the drafting of drought prevention strategies (to be presented to decision makers for approval) and the development of action plans at provincial and district level.

NEWU disseminates early warning information to farmer organisations, who in turn relay messages to local communities. NEWU produces bulletins of the agro-meteorological outlook which are distributed freely to government departments, national newspapers and civil society organisations in English and local languages. Recently NEWU partnered with telecommunications companies such as Econet Wireless in order to disseminate information to farmers through SMS alerts and radio broadcasts. NEWU also carries out campaigns on drought awareness and mitigation through workshops with Farmer Organisations and outreach programmes for remote communities in partnership with agencies such as FAO, WFP, UNOCHA, and the Civil Protection Unit.

Sustainability and Effectiveness

The sustainability of the system is high as the system is maintained and operated by competent government staff. NEWU also benefits from technical backstopping from the Southern Africa Development Community (SADC). Financial support to maintain the system at sub national level is provided by donor agencies such as UNOCHA and private sector organisations such as Econet Wireless.

Parallel to the NEWU EWS, local communities also use traditional Early Warning and forecasting methods for guidance on drought and other hazards. These informal approaches include drawing conclusions on the start of the dry season, the frequency of whirlwinds and the frequency of East-Westerly winds from the timing of the flowering and fruiting of certain tree species (such as Strychnos madagascarensi, Colophospermum and Azanza garckeana). The existence of this parallel system adds an additional challenge to the effectiveness of the formal NEWU EWS.

One national level obstacle to EWS effectiveness relates to overlapping agency mandates for information dissemination. For example, both NEWU and the Met Office view it as their responsibility to communicate drought warning messages to communities, and separate warnings can cause confusion. Another barrier to EWS effectiveness relates to the fact that end users are not at the heart of the system. Information flows upwards from provinces to the national level and then to decision makers at policy level. Information dissemination to farmers is poor, with farmers relying on basic SMS alerts that convey very little information, or infrequent visits from extension officers. Furthermore, information on the likelihood or impact of drought is politically sensitive and early warning messages are often suppressed, impeding community or humanitarian early action.

Current research

Zimbabwe's Civil Protection Unit is researching the 'Effectiveness of The Multi-Hazard Early Warning System Framework: An alternative for Zimbabwe'. The research's main objectives are to evaluate the effectiveness of the current National Early Warning System, and to explore the benefits of the Multi-Hazard Early Warning System Framework being proposed by the Hyogo Framework for Action 2 as an alternative approach for Zimbabwe. The results of the research have not yet been published.

Research gaps

Research could investigate how traditional methods of EWS can be used in conjunction with scientific EWS methods. Rural populations across Zimbabwe utilise traditional EWS monitoring traditional indicators. To effectively introduce scientific EWS to these communities, it will be critical to find ways to integrate the two.

Research could assess effective roles and responsibilities in drought early warning and early action. Inadequacies in the current system (where roles and responsibilities are not clear) lead to delays, which hinders humanitarian response during times of crisis.

4.2 Malawi: Flood Early Warning Systems in Malawi

Background

Flooding is a key hazard in Malawi, recognised in the Malawi National Adaptation Programme of Action[42] and in annual National Disaster Contingency Plans[43]. Between 1967

[42] http://unfccc.int/resource/docs/napa/mwi01.pdf.

and 2003, 18 floods were recorded killing at least 570 people, leaving 132,000 homeless, and affecting a total of 1.8 million people[44].

National early warning information is provided by the Department of Climate Change and Meteorological Services (DCCMS) and the Department of Water Services (DWS). The DCCMS operates a network of 21 surface observing stations, 27 automatic weather stations, 63 rainfall loggers, a satellite receiving station and over 100 rainfall stations across the country for the purpose of producing early warning information. In addition, the DWS has water gauging stations installed in major rivers across the country for flood monitoring. Forecasts and warnings are disseminated through radio, television, internet, bulletins and newsletters. The DCCMS provides weekly rainfall forecasts that are complemented by 48 hour updates. This information is utilised by community members guided by the Civil Protection Committee (CPC).

Current flood early warning to at-risk communities is limited, owing to several factors including the fact that the DWS does not have gauging equipment in all rivers. To improve early warning and disaster preparedness at community level, the Evangelical Association of Malawi (EAM) in partnership with Christian Aid (CA) and the Chikwawa District Assembly (DA) (with DIPECHO funding from the European Commission) implemented a Community-Based Disaster Preparedness and Response project (CBDPR) in 12 villages targeting 1,289 households. With the aim of developing a people-centered EWS that is understood, used and maintained by communities, the project has established rainfall and river water data collection systems and a community information dissemination system.

Community-based Early Warning System in Action
In March 2009, in the Chikwawa district of Malawi, heavy rains were experienced in upland areas. The local branch of the Civil Protection Committee (CPC) upstream alerted their downstream counterparts of rising water levels.

Using a megaphone, the CPC chairman immediately issued a 'yellow' alert warning about possible flooding to households. The alert and warning messages were disseminated to nearby villages, warning people not to cross the Mwanza river, not to wash, collect water or work along the river banks.

Sustainability and effectiveness

There is a lack of integration between community level and national level early warning systems, which poses a challenge to effective CBEWS. A key challenge to scaling up, institutionalising and raising the sustainability of community level pilots is ensuring that DRR is an integral part of district development planning and budgeting. The absence of funding to cover recurring EWS costs at local government and community level remains a key constraint to enhancing risk and early warning systems. Other areas that might help overcome some of these challenges, but are yet to be explored, include the potential role for the private sector to support early warning and for telecommunication networks and mobile phones to be used in EWS communications and flood warning.

43 Malawi Government (2012) National Contingency Plan Malawi 2012–2013

44 The World Bank, RMSI, IFPRI (2009) Economic Vulnerability and Disaster Risk Assessment in Malawi and Mozambique - Measuring Economic Risks of Droughts and Floods. Available from: http://www.preventionweb.net/files/15520_gfdrrecon.vulnerabilitydrrmalawimoz.pdf. Last accessed 13th November 2013.

Current research

In collaboration with the United Nations International Strategy for Disaster Reduction, the Southern African Development Community (SADC) is developing a framework for DRR based on the Hyogo Framework for Action pillars (which includes risk assessment and early warning). The Office for the Coordination of Humanitarian Affairs has just launched a research initiative which will involve SADC focusing on indicators for resilience. The UK Department for International Development, Irish Aid and the Norwegian Embassy are funding the “Developing Innovative Solutions with Communities to Overcome Vulnerability through Enhanced Resilience” (DISCOVER) project, and the “Enhancing Community Resilience Programme” (ECRP) to address limited community access to climate services. Within both projects there is a focus on small-scale farmers’ access to effective EWS (for flood and drought); farmer forecasting (seasonal and short-term weather forecasts); and adaptation to long-term, incremental climate change. Most of the research from these projects is not yet publicly available. In relation to early warning systems, the goal is to increase the number of automatic and/or manual weather stations, that provide information locally and to district disaster management institutions.

Research Gaps

Research is needed on the most effective ways to increase the number of people within communities reached through various communications channels. Different locations and different at risk groups will benefit from different dissemination approaches. Engaging the Private Sector in EWS is important as the private sector can potentially be engaged in risk transfer relating to floods (or droughts), through insurance or other mechanisms. Research could examine how the private sector can support CBEWS (and even the national system), including through private sector engagement in monitoring and dissemination of risk information (for instance, there is a clear opportunity for mobile service operators and agro-dealers within CBEWS).

SECTION 5

Case studies from South Asia

5.1 Nepal: Nepal Community Based Early Warning Systems

Background

According to the Bureau of Crisis Prevention and Recovery at United Nations Development Programme, Nepal ranks as the country fourth most at risk from climate change over the next 30 years, and the thirteenth most at risk for floods. Between 1971 and 2007, 2720 flood events were recorded, resulting in 2,936 deaths and nearly 3.5 million people affected[45].

Nepal does not currently have an effective weather-forecasting radar, which costs over US$3 million and is costly to maintain[46]. In Nepal's existing flood EWS flood information is generated at hydrological stations managed by the Department of Hydrology and Meteorology (DHM). Nepal has approximately 400 meteorological stations and 200 hydrological stations, out of which 73 are real-time stations. The real time stations provide flood information on an hourly basis, while the remaining stations are manual (i.e. where a gauge reader has to record data at a fixed interval of time every day and communicate this information (generally by telephone) to key individuals downstream and to the authorities responsible for district level disaster management.

The Nepalese Department for Hydrology and Meteorology (DHM) has teamed up with the NGO Practical Action (PA) to test Community Based Early Warning Systems within five river basins in Nepal (East Rapti, Narayani, West Rapti, Babai and Karnali)[47]. Community level disaster management committees have been formed in each targeted disaster prone village. These committees have been linked to a network of District Disaster Relief Committees, the local media, the Red Cross, local police, military units and the flood monitoring and forecasting station of the Department of Hydrology and Meteorology. The disaster management committees have been equipped and trained for warning dissemination, preparedness and immediate response.

The current EWS uses a combination of remote river monitoring, manual river monitoring, rainfall monitoring, and real time telemetry. Automated hydrological stations use a telemetry system which monitors river levels 24 hours a day and provides real time information using multi-channel communication, including SMS and Internet.

Challenges to sustainability

45 Source: Nepal-DesInventar, (NSET Nepal, UNDP, and www.desinventar.net)

46 It should be noted, however, that through the Pilot Programme on Climate Resilience (PPCR) a new information system will see the installation of three Doppler weather monitoring radars nationwide (WSR-88D - costing $2 million each) capable of forecasting heavy rainfall and drought through DHM. More information is available at http://reliefweb.int/report/nepal/piloting-agro-meteorological-early-warnings-nepal%E2%80%99s-farmers (Last accessed 15th November 2013)

47 For more information visit http://practicalaction.org/safer-nepal (Last accessed 15th November 2013)

Technical challenges - The system's continued reliance on manual river level monitoring and data collection restricts the timeliness and reliability of warnings. Likewise the lack of remote/upstream gauge stations reduces the lead time of river level related warnings. Automatic hydrological stations providing real time river level data utilise GSM cards. The fact that these cards need to be recharged every seven to 10 days adds an additional burden, and more importantly a potential flaw in the system as data collection is disrupted when the card is not recharged promptly.

Institutionalisation and capacity building – Lack of community capacity to operate, maintain or repair local EWS equipment is a barrier to the system's effectiveness. Lack of clarity amongst established institutions on their roles, responsibilities and mandates is a challenge (ownership, at all levels, has to be an integral part of a functional EWS). Critical community level institutions responsible for EWS (such as the Local Disaster Management Committees) need to become embedded within the local government system.

Institutional collaboration: Currently, there is infrequent data and information exchange between DHM and the District Emergency Operation Centre (DEOC) on meteorological conditions, river level conditions and forecasts. If this linkage could be improved, the DEOC's function and ultimately the CBEWS could be more effective.

Equipment and Communication problems: Unstable electricity supply disrupts readings and key EWS equipment. Telecommunications systems often fail during periods of high rainfall, disrupting the dissemination of vital warnings. Equipment is not always fully operational either because of a dependence on external technical backstopping or a lack of funding.

Financial barriers: There are no dedicated funds to promote EWS.

Lack of systemic monitoring and evaluation: The effectiveness of any CBEWS can be improved through a regular EWS evaluation process, taking into account effectiveness at community, local and national levels.

Current research

The Climate Division of DHM are currently researching rainfall-runoff models, using 2-3 days of rainfall data from a satellite based model, to determine potential flood impacts for Nepal. The UK Natural Environment Research Council is supporting research collaboration between Lancaster University (UK) and Practical Action Consulting (the consulting wing of Practical Action). This research will develop and pilot an operational probabilistic flood forecasting model for the Karnali River Basin, Nepal, combined with providing capacity building support to the Nepalese Department of Hydrology and Meteorology to enhance early warning.

Research gaps

How best to increase lead time: Research is needed on how we can improve CBEWS to increase lead time for warnings so that communities will have more time to mobilize themselves, their assets, and evacuate as necessary. There is a need to find ways to effectively link upstream and downstream communities, in a way that improves lead time.

Landslide prone areas and EWS for landslides: Research is needed on areas prone to landslides, as they can also trigger floods, and since the meteorological conditions which cause floods and landslides, are directly related.

Multi-hazard approach to EWS: DRR and EWS should be an integral part of sustainable development, particularly since Nepal is prone to several different types of hazards.

Flood threshold levels: More research is needed on flood threshold levels, as rivers can change course (owing to dams and other obstructions) which significantly decreases lead time for warning, let alone evacuation of communities. This can help predict, at given thresholds levels, how likely a flood is to occur and which regions are most at risk.

Hazard and vulnerability Maps: More efforts are needed to assess vulnerability, generate risk scenarios and vulnerability maps in collaboration with weather satellites and forecast data. This would better enable NGOs and Government to target EWS efforts and prioritise where the system should be scaled up.

Information services: More research is needed to better understand communities' needs and preferences for information type and presentation, so that EWS equipment and approaches can be made more user-friendly.

Promotion of traditional knowledge: People residing in flood prone areas have traditional knowledge that can be combined with scientific tools and techniques for forecasting and flood warning.

Improved risk and hazard information: Risk assessment should lead to the establishment of critical thresholds for early warning. Hazard maps alone are insufficient.

Improved monitoring and warning: there is a need to find out which equipment, and which data transmission systems works best in which area (as this varies from place to place). There is scope for research on monitoring to dramatically improve lead time.
Improved communication and dissemination: there are weakness in the communication and dissemination of information to alert and warn communities. Research is needed to customise early warning to local areas.

5.2 Bangladesh: Bangladesh's Flood Forecasting and Early Warning System

Background

Given its position on the world's largest delta, flood is the most frequent natural hazard for Bangladesh causing significant devastation across the country. In 2007, for example, two successive floods affected 16 million people across 46 districts (out of Bangladesh's 64 districts) causing damage exceeding US$1 billion[48]. In a normal flood year, 20% of Bangladesh is flooded, with over 60% of Bangladesh flooded in major flood years[49]. There are 45.5 million people in Bangladesh who are exposed to severe and moderate floods.

To reduce loss and damage from floods, forecasting and warning systems are in place at national and local levels. The Flood Forecasting and Warning Centre (FFWC) of the Bangladesh Water Development Board (BWDB) is the governmental body responsible for issuing flood forecasts. On a daily basis the FFWC issues 3-day flood forecasts extrapolating from water level measurements in rivers taken at 99 separate locations across the country, incorporating meteorological forecasts, like rainfall. Regional offices of the BWDB are responsible for monitoring water levels at those 99 points and communicating data to the FFWC. Inundation maps are also produced at a national scale.

48 Disaster Management Bureau (DMB), 2007. Consolidated Damage and Loss Assessment and Lessons Learnt from the Flood 2007 and Future Action Plan. http://www.ddm.gov.bd/pdf/Executive%20Summary-Flood%20Report.pdf

49 Climate Change Cell (CCC), 2009. Characterizing Country Settings: Development of a Base Document in the Backdrop of Climate Change Impacts. Climate Change Cell, Dhaka.

Sustainability and Effectiveness

With increased variability and uncertainty under climate change scenarios, accurate and effective flood forecasting is becoming an ever increasing concern. The crucial *Bangladesh Climate Change Strategy and Action Plan* (2009) envisages the 'Improvement of Flood Forecasting and Early Warning Systems' under the 'Comprehensive Disaster Management' thematic area.

Lead time continues to be a big issue. The FFWC is now 'experimentally' issuing 5-day flood forecasts for 38 stations under the Comprehensive Disaster Management Programme (CDMP) II. The FFWC is also experimentally issuing 10-days flood forecasts for 18 stations under the SHOUHARDO II Programme with technical help from RIMES[50].

Dissemination of nationally produced warnings and forecasts, and interpretation of implications at sub-national or community level remains a major challenge. In terms of dissemination of early warning, the established government system is guided by the protocols outlined in the national *Standing Orders on Disaster* (2010). At district level District Relief and Rehabilitation Officers are responsible for collecting information on water levels from various national and local sources, including local BWDB offices and Flood Information Centres. District Relief and Rehabilitation Officers then communicate early warnings to local Disaster Management Committees (UDMCs, embedded within the lowest tier of local government or Union Council) via the sub-district (Upazila) Disaster Management Committee. The UDMC is responsible for disseminating flood warnings to communities along with other risk reduction and emergency activities.

At present many communities are able to by-pass the above chain of communication, drawing upon direct flood warnings accessed through various sources (mobile phone, TV, radio). Local media broadcast some forecasts from FFWC or the Department of Disaster Management, and communities where BWDB stations are located are able to source information directly from there. However, these informal dissemination channels only provide information on rising water levels in nearby rivers, and do not provide longer lead time (5 to 10 day) early warning flood forecasts, which are only available on the FFWC website. These forecasts are available, so the reasons for low community demand for and low dissemination of these forecasts needs to be better understood. The Department of Disaster Management has attempted to work with mobile phone operators for enhanced early warning dissemination, but pilots to date have not resulted in impact at any significant scale.

In addition to the FFWC produced national forecasts, some local level flood forecasting arrangements are in place facilitated by NGOs and led by communities. In one system bamboo or wooden poles or pillars (as a scale or gauge) have been erected by a community at different important points in a river or wetland. Increases and decreases in water level are measured from these scales on a regular basis throughout the rainy season. In some areas, flags with different colours (white and blue) and different numbers (1 or 2) are used to signify increases or decreases in water level. In these cases, water level measurements are interpreted in locally understandable ways (like one span or two spans). To disseminate water level information several methods are used ranging from public announcement systems (hand-held megaphones or mosque PA systems), door to door dissemination, or dissemination at public places (e.g. bazaars, tea-stalls) by community volunteers.

One challenge to effective EWS relates to determining what 'danger level' means for villages far away from the BWDB's 99 water gauge points. Such local interpretation is a major challenge due to the dynamic nature of floodplains and rivers. Locally installed gauges or

[50] Regional Integrated Multi-Hazard Early Warning System for Africa and Asia

flag system could be an option to downscale flood warnings, but these systems are best suited to short lead time early warnings, not to 5 or 10 day forecasts.

In the case of flash floods, transboundary weather information sharing plays a very important role in Bangladesh since 93% of the catchment area of Bangladesh's rivers lies outside of Bangladesh. Inter-agency communication remains a challenge. Heavy rainfall beyond the North-East boarder of Bangladesh in India can help FFWC/BWDB to predict flash floods only if such information is effectively and promptly communicated.

Current research

Studies have been undertaken into how people use and respond to flood early warnings[51]. The effectiveness of flood warning dissemination system has also been studied with different communities[52]. A study has been completed to assess the feasibility of seasonal flood forecasting in Bangladesh[53].

Research gaps

1. Flood forecasting with enhanced lead time has been piloted in Bangladesh, but such pilots have not been sustained. In order to secure investment in building capacity for longer lead time forecasts, greater evidence of the effectiveness and impact of such enhanced lead time would be useful. A **cost-benefit analysis of flood warning** with enhanced lead time could stimulate investment in this sector.
2. Research on how forecasts can support **crop insurance** or **micro-insurance** initiatives.
3. Research on the effectiveness of current flood forecasting and early warning could contribute to the current debate over **'loss and damage' in the UNFCCC negotiations**.
4. Since 2011, each of 4,500 Union Councils of Bangladesh now has a 'Union Information and Service Centre' (UISC) with internet facilities and dedicated staff. Research can be undertaken to understand how this public investment in ICT can be used effectively to produce and disseminate **'area-specific' flood warnings** for local communities.
5. Public acceptance of warnings is very important. Studies can analyse **community perceptions and reactions to 'probability' elements** in flood forecasts and warnings.
6. The flood warning system is actively used throughout the annual flood period (maximum one quarter of the year). To increase effectiveness and sustainability, it requires **year-round activity with a decentralized, implementation body** at the community level.
7. Research to assess the capacity of sub-national government authorities in issuing, tracking and disseminating early warning messages to at risk communities.
8. Research to develop easily understandable community early warning tools.
9. Research can assess whether existing warning messages (content, clarity, language) for at risk communities are understandable and easy to transform into action by people living in flood-prone areas. If not, how this can be improved.

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51 Shah, et al., 2012 Flood warning responses of farmer households: a case study in Uria Union in the Brahmaputra flood plain, Bangladesh, Journal of Flood Risk Management, Volume 5, Issue 3, pages 258–269, September 2012

52 Rahman et al., 2013 Study of early flood warning dissemination system in Bangladesh, Journal of Flood Risk Management, Volume 6, Issue 4, pages 290–301, December 2013

53 Chowdhury, 2005, Consensus Seasonal Flood Forecasts and Warning Response System (FFWRS): An Alternate for Nonstructural Flood Management in Bangladesh, Environmental Management, June 2005, Volume 35, Issue 6, pp 716-725

10. What are the challenges to utilising Cell Broadcasting System or SMS (through mobile phone operators) to disseminate flood forecasting to at risk communities? And how can these be overcome?
11. Forecasting flash floods is still challenging due to a lack of trans-boundary information sharing (and a lack of sophisticated cloud based modelling).
12. Flood warning: Research can consider how to change the current port based signalling system into a contour based system.

5.3 Bangladesh: Cyclone Early Warning and Volunteerism in Bangladesh

Background

Bangladesh's Cyclone Preparedness Programme (CPP) offers an excellent example of effective cyclone early warning dissemination. The CPP is a joint venture of the Government of Bangladesh (Ministry of Disaster Management and Relief) and the Bangladesh Red Crescent Society (BDRCS). This Programme was started in 1972 in response to a devastating super cyclone in which 500,000 people were killed (12 November 1970). The CPP currently has 49,365 volunteers (32,910 male and 16,455 female) across 13 coastal districts (out of Bangladesh's 64 districts). The CPP therefore serves a significant portion of the total population of 160 million.

On average Bangladesh is hit by a severe tropical cyclone every three years. In 2007, around 1.5 million people took refuge in cyclone shelters when Cyclone Sidr struck Bangladesh. Cyclone Mahasen (May 2013) is the latest example of mass evacuation guided by CPP volunteers and other humanitarian agencies.

Sustainability and Effectiveness

National *Standing Orders on Disaster* (2010) guide all disaster management activities in Bangladesh. This document clearly defines the roles of CPP volunteers and officials from union (the lowest local government unit) to national levels. The CPP is governed by established rules and processes, for example, numerous requirements have to be fulfilled to become a CPP volunteer (entry age is 18 to 30 years, must have passed educational standard VIII, should have financial solvency, and should be able to pay induction fee and fixed annual fee. An applicant has to go through a rigorous process of selection, examination and probation). Without monetary incentives, CPP volunteers find motivation through gaining respect and self-fulfilment through helping protect their communities from cyclones and storm surges.

CPP volunteers are trained on early warning dissemination, evacuation, search and rescue, first aid, as well as basic disaster management and leadership. Outside of emergency periods they are also responsible for raising awareness of hazards and building understanding of and support for disaster preparedness in their communities.

The CPP is sustained through government and donor support. Government funding is mainly used to cover recurring costs, whilst training programmes and volunteer equipment is usually covered through donor financing.

The CPP has undergone a variety of changes in the four decades since it was established. One evolving challenge relates to volunteer motivation and retention. In recent years the programme has found it increasingly difficult to maintain the motivation and active participation of volunteers in the gaps between disasters and formal CPP events (refresher training or awareness raising events). To overcome potential inertia or decline between

formal CPP events (or disasters), as well as to maximise the effectiveness of CPP volunteers, a number of additional strategies are being piloted.

There have been several sporadic attempts within the CPP to engage its volunteers in livelihood and microcredit activities, to give volunteers a clearer remit between disasters and to start to get them focused on longer term resilience building rather than just short-term disaster preparedness. However, much more can be done as at present the CPP's focus remains squarely on disaster preparedness rather than risk reduction and resilience. This narrow focus on preparedness amongst CPP volunteers is not only a lost opportunity in terms of resilience building, it is also a risk to the preparedness and early warning agenda itself, as it become hard to maintain volunteer motivation and commitment between disasters.

Another dilemma faced by the CPP is the debate between pure volunteerism versus the allocation of monetary benefits in the name of the CPP. Weighing up the sustainability and continued effectiveness of a purely volunteer based system, versus a more professionalised (and financially supported) system is an ongoing challenge.

Current research

The Government of Bangladesh's *Climate Change Strategy and Action Plan* (2009) noted that "During Cyclone Sidr, gaps in the CPP network were exposed". It proposed an urgent need to review the system and make improvements as necessary. The Comprehensive Disaster Management Programme is conducting an assessment of CPP's current capacity. It is also studying the effectiveness of early warning for Cyclone Mahasen (May 2013). Studies on volunteer motivation have been conducted[54]. What factors hinder cyclone evacuation despite extensive early warning dissemination and shelter options has also been studied[55].

Research gaps

1. Research on whether the CPP **will be resilient to climate change and variability.**
2. Given recent improvements in ICT, research could look at the role of **CPP volunteers in dissemination of cyclone early warning**.
3. Research on the advantages, disadvantages or trade-offs between **pure volunteerism versus incentive-based volunteerism.**
4. Analysis of the effectiveness of 'Community Radio' and 'Interactive Voice Response (IVR)' mechanisms for cyclone and flood early warning.
5. Analysis on whether disaster-prone communities receive weather forecasting and early warning in a timely manner that enables them to take appropriate early action.
6. Proposed revisions to the cyclone/high wind Early Warning signaling system have not yet been implemented. Research can help assess how this system can be improved (taking into account how early warning ratings are compiled and disseminated).
7. Research on how to ensure early warning messages reach all vulnerable groups (e.g. including fishermen far out at sea).
8. Pilots linking union information centres and cell phone companies to develop and disseminate early warning messages to the most vulnerable.
9. Fine grid analysis and simulation to improve cyclone forecasting.

54 Amin, M.R., 2012. Motivating volunteers: a case of cyclone preparedness programme volunteers in Bangladesh. http://dspace.bracu.ac.bd/handle/10361/2724

55 Paul, B.K., Rashid, H., Islam, M.S. and Hunt, L.M., 2010. Cyclone evacuation in Bangladesh: Tropical cyclones Gorky (1991) vs. Sidr (2007). Environmental Hazards 9: 89-101. http://www.tandfonline.com/doi/abs/10.3763/ehaz.2010.SI04#.UoSD9hXxLIU

SECTION 6

Case studies from the Caribbean

6.1 Dominican Republic: Early Warning System in Tamayo Municipality

Background

An early warning system (EWS) was launched in 2010 in Tamayo municipality, in the middle part of the Yaque del Sur river basin in the Dominican Republic. The EWS was physically installed in Tamayo, but serves a significant part of the river basin beyond this municipality. It is jointly administered by the Municipal Committee for Prevention, Mitigation and Response (CPMR) of Tamayo, the national Office of Civil Defence, and the Dominican Institute for Integral Development (IDDI), an NGO supported by Oxfam.

Tamayo, like many municipalities in the Dominican Republic, is highly vulnerable to disasters due to poor socioeconomic conditions, high rates of unemployment, dependency on fluctuating remittances from abroad, and low levels of education. Public investment in Bahoruco province (where Tamayo is located) is among the lowest in the country.

Tamayo has a vast number of “bateyes”, sugar worker towns founded in the 17th and 18th centuries, which are mainly inhabited by Haitians and by Dominican nationals who are descendants of Haitians. These communities have high levels of poverty and combined with poor access to national public services. The area is characterised by overexploitation of natural resources, including forests, soils and watersheds, mainly due to unsustainable farming (agricultural and livestock) practices.

The main hazard faced by Tamayo is flooding. A hurricane in 1908 caused the largest flood registered in the area, which destroyed the community of Hatico (located 6.2 Km northeast of Tamayo), and Hurricane George in 1998 caused massive floods across Tamayo and the wider Yaque del Sur river basin[56]. Floods are caused by tropical cyclones, heavy rain combined with environmental degradation (including deforestation and erosion in the upper parts of the river basin) and dam operations within the area. Floods have led to significant economic damage and occasional loss of human life. Other key hazards in the area include forest fires and earthquakes.

The EWS covers the population of Tamayo (23,000 people according to the 2010 Census), as well as residents of communities in the lower part of the basin, including Jaquimeyes, Pescaderia, La Hoya and Habanero. The municipal authority (CPMR) responsible for the Tamayo EWS coordinates with their counterparts in other settlements across the province.

Tamayo’s EWS has installed a network of radio transmitters (managed by municipal authorities – the CPMR) across area, which are linked to the national Office of Civil Defence’s communications network. Tamayo’s EWS maintains a network of monitoring

56 Cocco Quezada, Antonio y Gregorio Gutiérrez Pérez (Sep. 1999). "El huracán Georges en la República Dominicana: Efectos y lecciones aprendidas". Washington, D.C, US; Online at: http://www.cridlac.org/cd/cd_huracanes/pdf/spa/doc12138/doc12138-contenido.pdf

points to measure water level and velocity. Authorities were provided with basic equipment for emergency response (ropes, gloves, first aid kits). Tamayo and other municipalities were provided with emergency bells to activate the EWS. Training was provided to 24 municipal authorities (CPMRs) covering the use and maintenance of EWS equipment and the implementation of emergency protocols, including completion of drills and simulations. Data from monitoring points is interpreted to determine the level of an alert, green, orange or red, and with higher warnings activating emergency protocols, including communication with CPMRs in other locations through the radio network, the use of emergency bells and evacuation procedures.

Sustainability and effectiveness

The Tamayo EWS is well embedded within the national system, providing a foundation for sustainability. Protocols underpinning the Tamayo EWS have been agreed with the national Office for Civil Defence, supported by a signed letter of understanding. Ongoing monitoring of the Tamayo EWS is implemented jointly by the national Office for Civil Defence and the municipal authorities. Municipalities in the area have committed financial support to sustain the EWS, with local government funding complemented by public contributions (the national office of Civil Defence coordinates fundraising activities during Easter and Christmas festivals).

Efforts are underway to ensure the Tamayo EWS is linked up or replicated nationwide. The Tamayo EWS is already embedded within the national system through protocols signed with the national Office of Civil Defence, and the radio network used by local operators is used nationwide. The Tamayo EWS also shares the common features with other EWS installed throughout the country. More can be done to ensure that best practices at local level are replicated nationwide, and the EWS also needs to be linked with the National Institute of Hydraulic Resources (INDRHI), the agency responsible for dam management and control, to strengthen the management of the Yaque del Sur basin.

A barrier to EWS effectiveness is the lack of coordination and cooperation between authorities responsible for the management of dams and authorities responsible for disaster preparedness and early warning. During Tropical Storm Olga in 2007, the lack of information regarding dam management resulted in the loss of human lives[57]. Another impediment to the effective functioning of the Tamayo EWS is the lack of information (at local authority level) on conditions in the upper part of the watershed.

Despite continuing areas for improvement, there is evidence of the Tamayo EWS' impact. During emergencies in 2011 (Hurricane Irene) and 2012 (hurricanes Isaac and Sandy), municipal authorities (CPMRs) responded actively, coordinating well with national emergency authorities.

One potential trend that could diminish the long-term effectiveness of the Tamayo EWS is reduced cyclone activity. During 2013, tropical cyclone activity was lower than in previous years, with no major hurricane registered in the area for the first time since 1994. The EWS may lose its strength if momentum (and simulations or drills) is not sustained through periods of reduced cyclone activity.

Current research

There is no current research examining the effectiveness or sustainability of the Tamayo EWS. Some research projects on EWS have been conducted at a national level, but these

[57] La Estrella, 13/12/2007, "Asciende a 25 saldo de muertes por tormenta Olga". Online at: http://www.diariolaestrella.com/2007/12/13/v-print/40467/asciende-a-25-saldo-de-muertes.html

did not include Tamayo's EWS. Oxfam submitted a proposal for research on the effectiveness and sustainability of the Tamayo EWS to the Ministry of Higher Education, Science and Technology in early 2013, but this proposal was unfortunately not funded.

On a more general level, the United Nations Development Programme (UNDP) recently led an evaluation of capacities related to climate risks and risk management in the agricultural and water sectors in the Yaque del Sur river basin[58].

Research gaps

i. How to improve the communication and coordination between all key EWS stakeholders, including links between local and national authorities responsible for early warning, and other important actors including authorities responsible for dam management.

ii. Potential to expand the Tamayo EWS to cater for other hazards, in particular forest fires and earthquakes, since this region is particularly vulnerable to such hazards.

iii. Three years after operations started, there is enough experience and information to conduct a rigorous evaluation of the Tamayo EWS's strengths and weaknesses, systemising the experience and proposing models for replication and adaptation to other areas.

58 UNDP and IISD (2013) Gestión de Riesgos Climáticos para el agua y la agricultura en la República Dominicana: Enfoque centrado en la cuenca del Yaque del Sur)

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Appendix B Compilers and key informants

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