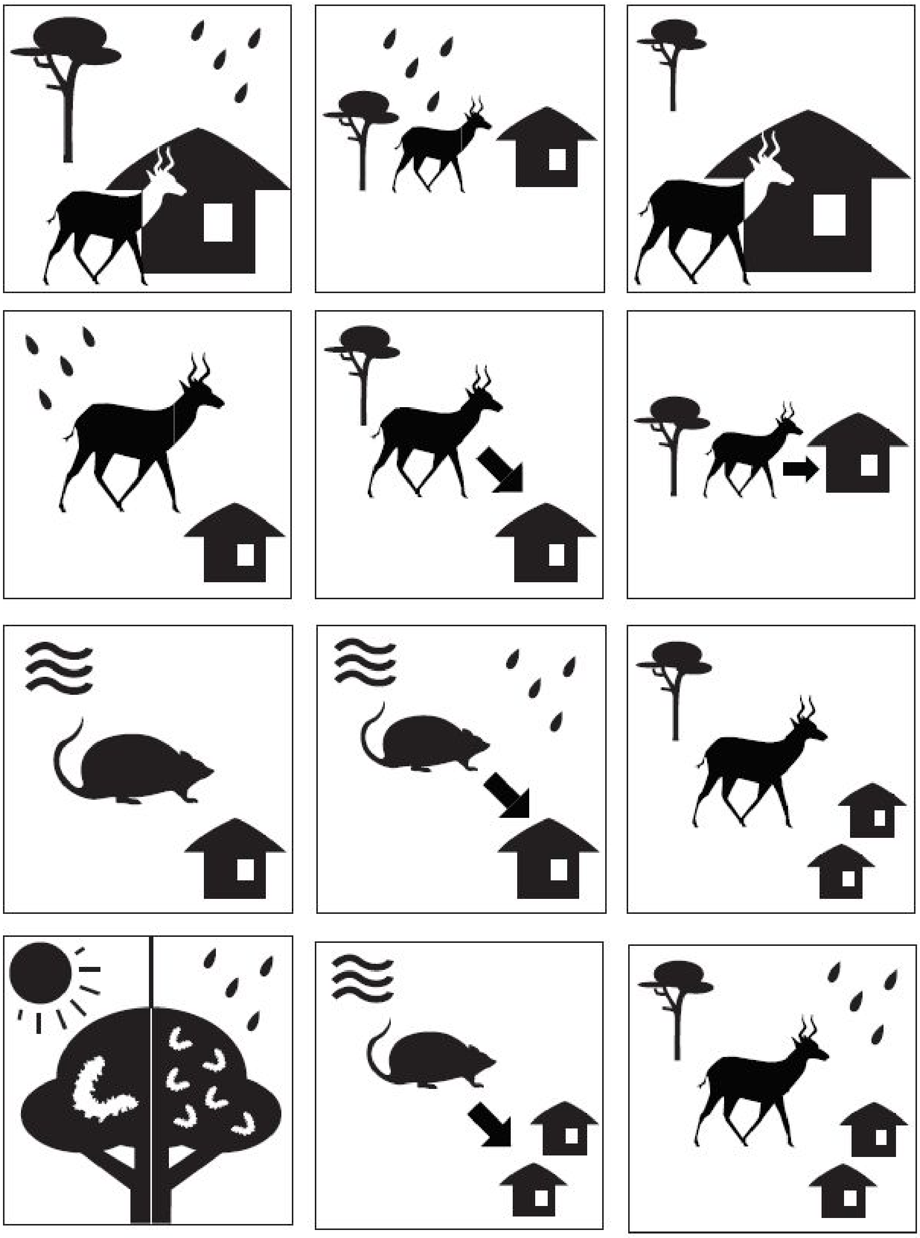
Indigenous knowledge and early warning systems in the Lower Shire Valley in Malawi



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Acronyms and abbreviations

CB-EWS	Community-based Early Warning System
CSO	Civil Society Organisation
DCCMS	Department for Climate Change and Meteorological Services
DoDMA	Department of Disaster Management Affairs
DRR	Disaster Risk Reduction
EWS	Early Warning System
FGD	Focus Group Discussion
GIS	Geographic Information System
MASDAP	Malawi Spatial Data Platform
GVH	Group Village Head
IK	Indigenous Knowledge
KII	Key Informant Interview
NGO	Non-governmental organization
PDNA	Post Disaster Needs Assessments
SDG	Sustainable Development Goal
UNDP	United Nations Development Programme
VCPC	Village Civil Protection Committee

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Summary

Background

This research has been done as a part of the EU ECHO Action *Enhancing resilience of vulnerable communities and building institutional disaster response capacity in Phalombe, Thyolo, Chikwawa and Nsanje (Malawi).* This study is part of the strengthening and institutionalising the Early Warning/Early Action capacity (Result 2 area), more specifically Activity 2.7: *Conduct a study and document indigenous early warning system*.

Malawi is prone to multiple hazards, with hydro-meteorological hazards of floods, droughts and dry-spells being the most common ones. The impacts of these events is especially prominent in the Lower Shire Valley, the most southern region of the country. The existing early warning systems for floods, dry-spells and droughts are not providing an accurate warning information in a timely manner. In addition, the existing EWS in the country does not take into account the rich indigenous knowledge held by community members. Through extensive experience in being impacted to these events and a history of living in the area, the local communities have developed various ways through which the forecast for impending hazard is made, by using locally available signs and indicators. Based on signs and indicators, locals have developed numerous actions to minimise the impacts. However, there is an obvious gap in terms of the available documentation and understanding of such practices in Malawi. With an increasing call for integration of indigenous and scientific information in early warning systems as a way to contribute to community resilience to natural hazards, there is a need to further understand the role of indigenous knowledge and its potential in designing people-centred early warning systems.

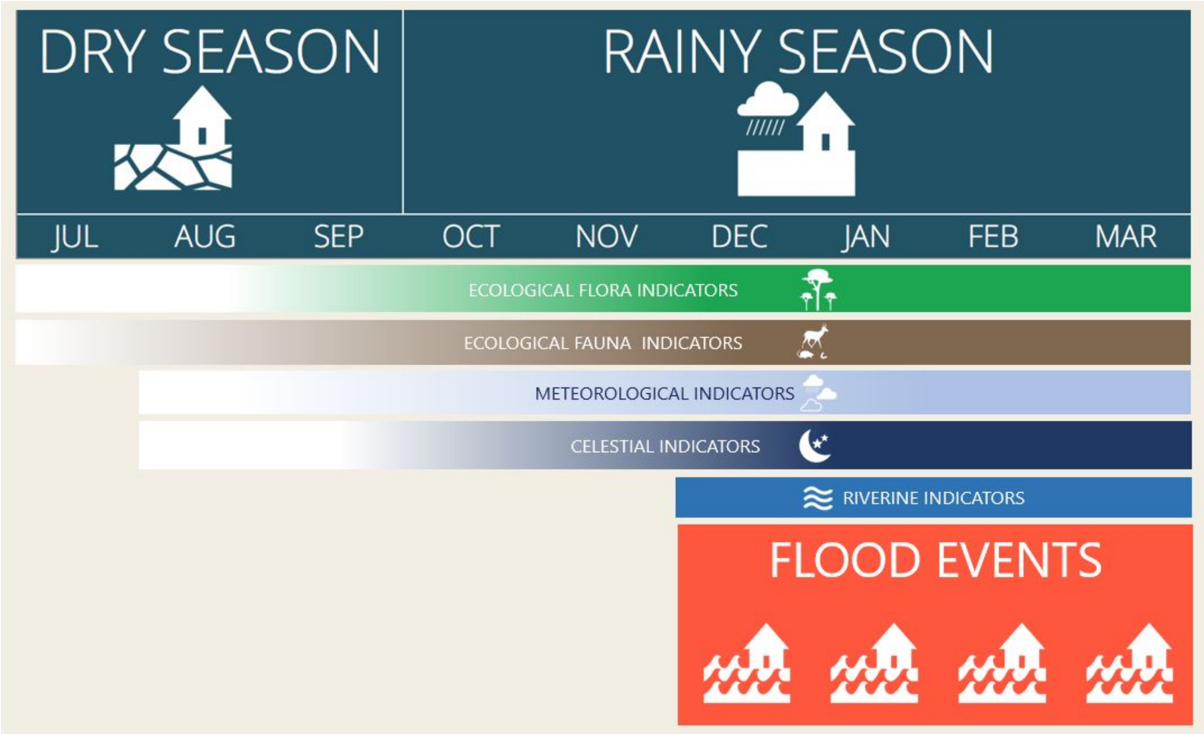
Study aims and objectives

The overall objective of this study is to understand and document the indigenous early warning signs for most common hazards (i.e. floods, droughts and dry spells) in the Lower Shire Valley. The study explores what indigenous early warning signs are available within communities, how these are shared within the community and if and how they are being used in preparing for and reducing the impacts of disasters.

Methods

The study used qualitative enquiry and data collected through gender-separated focus group discussions (n=31) and key informant interviews (n=25) in 17 communities (Group Village Head level) in the Lower Shire Valley. Fieldwork took place in September and October 2017 and was conducted by a team from the Malawi Red Cross Society. The research participants were selected using the purposive sampling approach after consultation with community leaders. The majority of participants were subsistence farmers with only a few fisherman and small business owners. All discussions and interviews have been conducted in local language, recorded, transcribed verbatim and translated to English. Data analysis employed a thematic analysis.

Results



Conclusions

1 Background and introduction

1.1 Malawi disaster profile: natural hazards and their impacts

Malawi is a country highly exposed to the impacts of natural hazards. Nkomwa et al. (2014) note the occurrence of floods, seasonal droughts, long droughts, dry and cold spells, strong winds, thunderstorms, landslides, hailstorms, mudslides and heatwaves. In addition, earthquakes, pest infestations, disease outbreaks and fires also contribute to the image of the country being highly disaster prone. As in the rest of Sub-Saharan Africa, floods and droughts present the most common disasters, and the available records from Malawi indicate the increase in frequency, intensity and magnitude of these calamities (DoDMA, 2015). Figure 1 shows the occurrence of river and flash floods as well as droughts in Malawi for the period of 2001 to 2016.

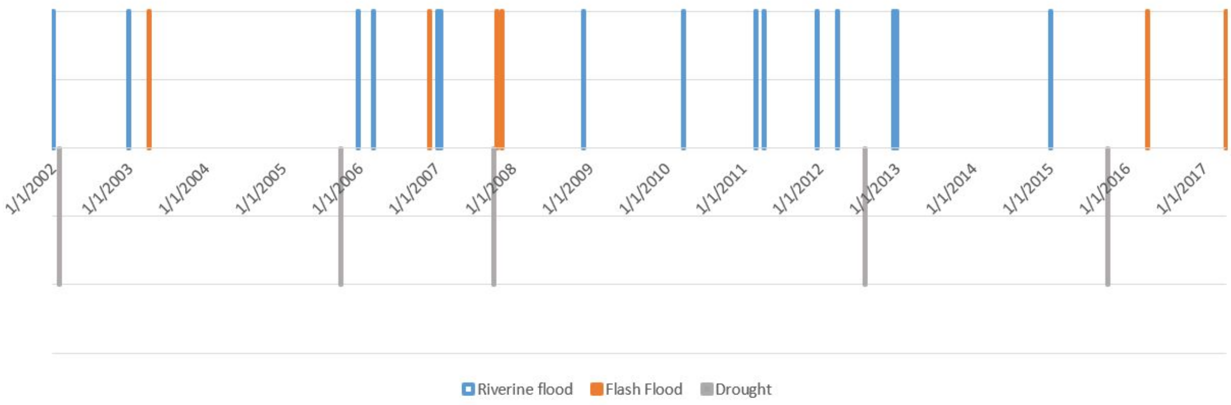


Figure 1 Overview of river floods (blue), flash floods (orange) and droughts (grey) in Malawi for the period of 2001 to 2016. Source EM-Dat, Visualization 510 Aklilu Teklesadik.

For instance, in some of the areas in Malawi, flooding presents an annual phenomenon, and very often the same areas that are prone to flooding are also prone to droughts and dry spells. The 12 month standardized precipitation index for southern Malawi has exceeded severe wet or dry thresholds (defined by SPI-12 score of <-1.3 or >1.3) in 12 of the past 26 years from 1990-2016. A high vulnerability to hydro-meteorological hazards can be primarily attributed to the effects of El Niño and La Niña on the climatic conditions in the country, and the influence of tropical cyclones on rainfall patterns and spatial distribution (GoM, 2016). These factors, combined with the rapid population growth, high levels of environmental degradation, lack of proper urban planning, high poverty levels and lack of access to services mark Malawi as a country under a severe disaster risk; with the advent of climate change presenting an additional threat for the further increase in the disaster risk and its impacts on communities.

In their study, Pauw et al. (2011) estimated that the combined effect of floods and droughts in Malawi cause losses of 1.7 % annually in Gross Domestic Product (GDP). Malawi has a predominantly rural population (i.e. 85% of the total population), agro-based economy, and approximately 70% of the total population living below the poverty line (GoM, 2016). Hence, hydro-meteorological disasters have severe consequences as they destroy the livelihoods, perpetuate the disaster-poverty cycle and increase food insecurity. For instance, the agricultural sector suffered close to USD 70 million damage in 2015 flooding (GoM, 2015a), and droughts of 2015/2016 caused close to USD 200 million losses (GoM, 2016). Next to agriculture, floods and droughts impact sectors of energy, education, transportation, social protection, nutrition, housing, health, environment, water and sanitation, commerce and trade. In each of the years of droughts and floods described above, food shortages that have required humanitarian response have been experienced in parts of central and southern Malawi. Recurrent floods and droughts also impact local communities' economic, cultural and psychological values (Lumumba Mijoni and Izadkhah, 2009), and affect market prices of the staple food.

1.2 Early Warning Systems and their Gaps in the context of Disaster Risk Reduction

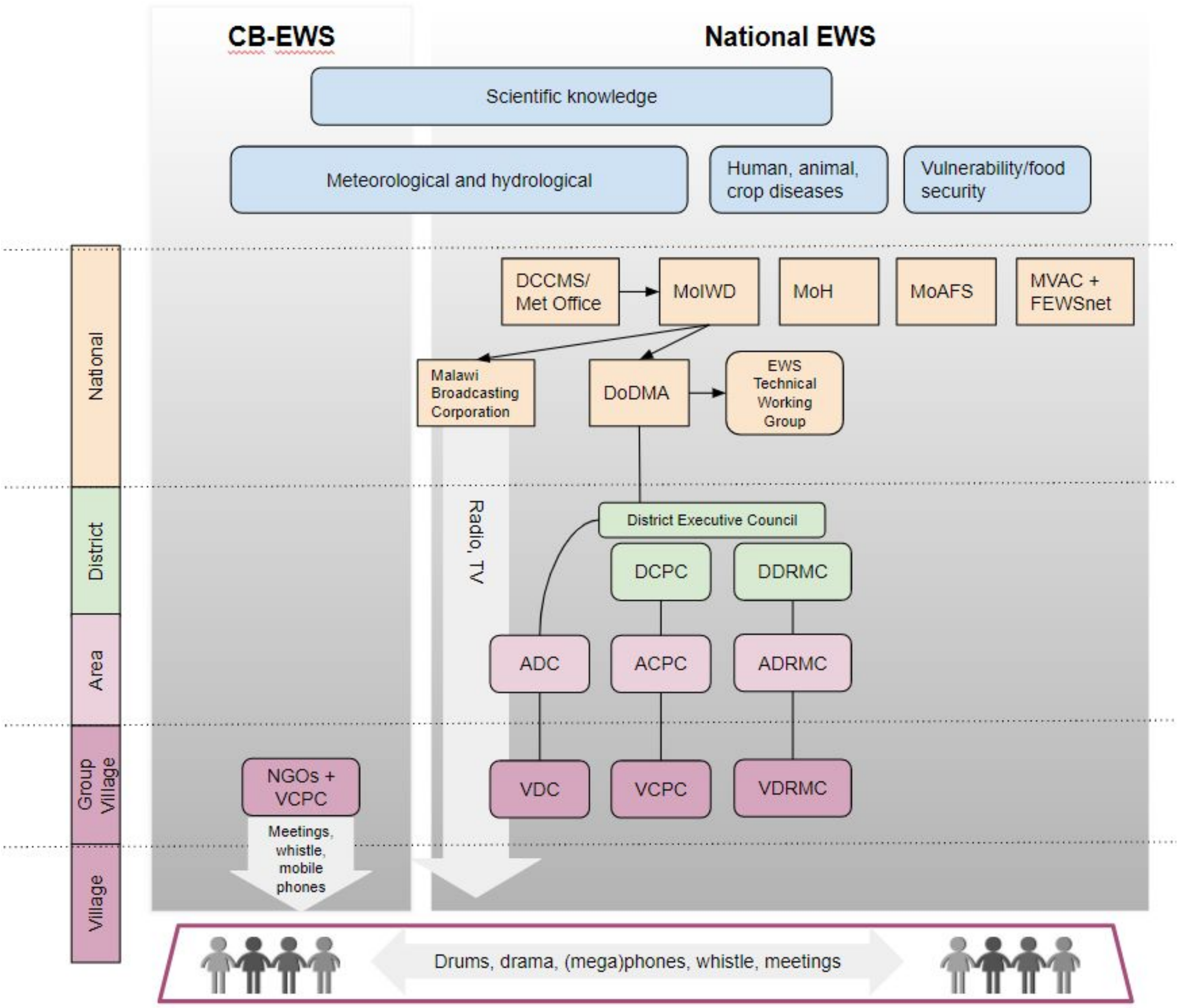


Figure XY Simplified overview of the Community based and national early warning system in Malawi. In this diagram, the dissemination of forecasts only for hydro-meteorological hazards is sketched. A similar overview could be made for the human/animal/crop diseases and food insecurity. Explain abbreviations.

To address the risk of loss and damage prior to and the loss and damage experienced after floods and droughts, a range of private and public actions can be taken. Private actions are those taken by the communities and households affected or to be affected and public actions can be taken by a broad range of local, national and global stakeholders, such as government entities, NGOs, CSOs and private sector, Actions can be part of Disaster Risk Reduction prior to the disaster or humanitarian emergency response after. DRR is mainstreamed into the legal and policy context in Malawi, but the existing approaches still favour relief assistance, although a number of preparedness and mitigation activities can be observed (Šakić Trogrlić et al. 2018). But essential for taking action is early warning, which is the focus of this. It is therefore important to identify and understand the gaps in the existing early warning systems for hydro-meteorological hazards in Malawi. The importance of effective early warning systems (EWS) for the overall DRR in Malawi is explicitly stated in the National Disaster Risk Management Policy, agreed upon in 2015, where one of the key policy priority areas is the 'development and strengthening of people-centred early warning system' (GoM, 2015b). Also, the key global agreements, the Paris Agreement, the Sendai Framework for DRR and the SDGs, have objectives on EWS, whereby the Global Target (g) of Sendai is the most explicit. Target (g) states "Substantially increase the availability of and access to multi-hazard early warning systems and disaster risk information and assessments to people by 2030", with six indicators (UNISDR, 2015).

Decades ago, communities in Malawi had to rely solely on indigenous EWS for both floods and droughts. Nowadays, the existing EWS for floods in Malawi consists of an official EWS at the national level and a series of community-based early warning system (CB-EWS), in addition to the indigenous EWS. The official EWS is manually operated system, based on the water level and rainfall readings and executed flood routing procedure (Shela et al. 2008; Nillson et al. 2010). The system is officially maintained by the Ministry of Irrigation and Water Development. An additional components of the official warning system is the Flash Flood Guidance system is run by the Department of Climate Change and Meteorological Services, that uses computer modelling and regional forecasts to issue warnings for flash flooding in the country. On the other hand, CB-EWS are implemented across Malawi by the non-governmental sector, often in cooperation with local government. As a part of these systems, in vulnerable areas manual rain gauges and colour coded staff gauges in the rivers are installed; with an accompanying training to community members on how to operate and maintain the systems, and how to disseminate the messages (Atkins 2012).

The information in the reviewed literature on the existing drought early warning systems operating in Malawi is limited. As reported by Chabvungma et al. (n.d.), existing drought monitoring in Malawi is based on the calculation of drought severity indices (e.g. Standard Precipitation Index, Normalised Difference Vegetation Index-NDVI), and weather forecasts; under the responsibility of the Department of Climate Change and Meteorological Services. The Department issues real time (up to 3 hours), short range (3 days forecasts on a daily basis), medium range (5-7 days forecasts twice per week) and long range, seasonal forecasts (3-6 months on a yearly basis) (Chiota et al. 2016). Seasonal forecasts are issued for the spatial resolution of a district, and once when the forecasts are issued, an effort is made by the local government and NGOs working in the districts to convey the information to the end-users (farmers) (Chavula, 2015). The Famine Early Warning System (FEWSnet) delivers food security early warnings, whereby data on drought and dry spell (such as NDVI) are among the many elements used in their modelling (FEWSnet, 2018)[1].

Despite recent efforts by different stakeholders, in improving the existing EWS system in Malawi, there is still a number of gaps to be addressed. In his review and evaluation of the existing system, Chavula (2015) reports a number of major challenges: data gaps, difficulties accessing the available data, lack of measuring meteorological and hydrological equipment, outdated systems, insufficient multi-agency cooperation, untimely warnings not targeted at end-users, inadequacy of temporal and spatial hazard information, existence of flood EWS only for few major rivers, warning communication challenges and many more. The report from the First Stakeholder Workshop on Enhancing Early

[1] http://www.fews.net/southern-africa/malawi/food-security-outlook/february-2018

Warning Systems in Malawi (Chiotha et al. 2016) identifies additional gaps in terms of the delay in the release of seasonal forecasts, lack of local level information, over concentration of risk reduction programmes in few districts, weak or non-existent local level structures, limited translation of scientific and technical jargon. In addition to the gaps identified above, both reports emphasize the need to integrate indigenous knowledge available within local communities into the existing EWS.

In conclusion, although communities can in principle rely on both the indigenous EWS and these scientifically grounded EWS, they often do not benefit from the scientific, national systems as early warning messages are often not received (lack of e.g. internet or mobile connection, lack of access to television and radios), not understood (message content too technical, not localized) or acted upon (not sufficient means or knowledge to do so). (ref HFA national report 2013-2015)

1.3 Early Warning-Early Action as part of the EU ECHO Action on Enhancing Resilience

In March 2016, the EU ECHO action *Enhancing resilience of vulnerable communities and building institutional disaster response capacity in Phalombe, Thyolo, Chikwawa and Nsanje (Malawi)* started, with several of its objectives targeting the gaps identified in the previous paragraph. The action ended in March 2018 and worked in Group Village Heads (GVHs) areas (37 in total), that have very low capacity to cope with natural threats and epidemics and withstand shocks. Objectives at GVH level are (1) to make these GVHs aware of their vulnerabilities and capacities and increase their ability to organise effective disaster response; (2) strengthen Early Warning / Early Action capacity and institutionalise this capacity in the GVHs located along the most flooding rivers in Phalombe, Thyolo, Chikwawa, Nsanje and along lake Chilwa; (3) make sure the GVHs have adopted resilient livelihood strategies. At district level, institutional capacity on Disaster Risk Management is established and coordination amongst stakeholders improved.

Early warning/early action capacity (just before the disaster hits) can be seen as an extension to the response capacity (just after the disaster hits). Communities can be considered the first responders. In addition, the locally embedded Village Civil Protection Committees provide professional response capacity, as they are equipped and trained in responding to rapid-onset disasters and able to act as soon as a warning is received or when a disaster takes place. VCPCs offer search and rescue services and provide first aid where needed. The teams will also coordinate the evacuation from the affected areas to designated shelters, as per village level contingency plan. VCPCs get hereby the support from Red Cross volunteers.

Want to add here a part on what is achieved in terms of Early Warning Early Action; will check deliverables.

This study is part of the strengthening and institutionalising the Early Warning/Early Action capacity (Result 2 area), more specifically Activity 2.7: *Conduct a study and document indigenous early warning system*.

1.4 Objectives and scope of the study

The overall objective of this study is to understand and document the indigenous early warning signs for most common hazards (i.e. floods, droughts and dry spells) in the Lower Shire Valley. The study will explore what indigenous early warning signs are available within communities, how these are shared within the community and if and how they are being used in preparing for and reducing the impacts of disasters. These three main elements correspond to also to three of the four building blocks of an EWS, namely the Monitoring and Warning, the Dissemination and Communication and the Response Action. Risk knowledge is not part of the study.

The resulting documentation should support DRR practitioners and stakeholders in Malawi in further development of an inclusive EWS for floods and droughts by giving them concrete guidelines as to the variety of the indigenous knowledge available within the communities.

In the following section, overview of the literature on the role of indigenous knowledge will be presented, followed by a detailed account of the methodological approach taken in the study. Afterwards, the results of the study will be discussed, outlining various IK EWS found in communities and its usage, follow by the reflection on the perceived reliability of the indigenous and official EWS. Finally, main conclusions and recommendation from the study are presented.

2 Indigenous knowledge and disaster risk reduction: state of the art

Indigenous knowledge (IK) is increasingly being seen as one of the critical components in reducing disaster risks at local levels, building resilient communities and sustainable livelihoods. In order to provide a theoretical framework for the present study, this section introduces IK in context of disaster risk reduction and early warning systems. It discusses benefits and limitations of IK and gives an overview of previous research done on IK in Malawi. Finally, in order to contextualise Malawian situation, it glimpses into international experiences of IK for DRR by providing examples from other parts of Africa and Asia.

2.1 'The devil in the detail': indigenous knowledge and disaster risk reduction

For decades, IK has drawn attention from researchers in variety of scientific disciplines (e.g. anthropology, geography, sociology, development studies), and it has recently been more extensively researched in the interdisciplinary field of DRR. Apart from the increased attention from research, also in the policy domain, indigenous knowledge is on the agenda. For example, Sendai emphasizes in several Priorities for Action, most notably the on on Understanding disaster risk, the role of indigenous (or traditional) knowledge and highlights the importance of involving indigenous people [2] (UNISDR, 2015). Historically, the outlooks and attitudes towards IK in academic research have shifted from denying it, seeing it as an obstacle to development, through the phase of romanticising it, and more recently, understanding its potential for effective DRR (Agrawal, 1995; Ouriachi-Peralta and Fakhruddin, 2014). Since the 1980s and the emergence of vulnerability perspective, the potential of IK integration and and its' stakeholders participation has increasingly been promoted by academia and international development and donor agencies (Dekens, 2007); with the experiences of indigenous communities in Indonesia affected by the 2004 Indian Ocean Tsunami pushing the topic in the research agendas (Shaw, 2009). Despite this growing recognition and prominence in research and development community, there is still insufficient evidence on IK practical application and its' effectiveness for DRR (e.g. Mavhura et al. 2013). Moreover, even though Africa is seen as one of the world's strongholds of IK (UNEP, 2008), a large majority of studies on the role of IK in DRR has been done for Asian, not African context (Mavhura et al. 2013). This identified gap presents an opportunity for the present study to explore how rural communities in the Lower Shire Valley utilise IK in forecasting and reducing the impacts of the two most common hazards: floods and droughts.

The use of the term 'indigenous knowledge' in the literature is very often contested, and terms such as 'indigenous knowledge', 'local knowledge', 'traditional knowledge', 'traditional ecological knowledge', 'traditional environmental knowledge', 'indigenous technical knowledge', 'folk knowledge' are often used interchangeably, without enough consensus and defined boundaries (Dekens, 2007; UNEP, 2008; Acharya and Paddar, 2016). However, these terms have similar meanings, encompassing knowledge specific to communities and environments (Dekens, 2007) and ultimately, all coming to meaning the same thing (Iloka, 2016). For the purpose of this study, a term IK is used, with adopting a definition from Mercer et al. (2010, p, 218), saying that IK is :

> '*considered to be a body of knowledge existing within or acquired by local people over a period of time through accumulation of experiences, society-nature relationships, community practices and institutions, and by passing it down through generations.*'.

The definition stresses out the inherent characteristic of the IK: its' embeddedness in local context. For communities living in disaster prone areas, IK presents essential mechanism do deal with everyday risks, and can be found across the disaster risk management cycle. Dekens (2007), whilst researching IK in Asian context, proposed a framework of IK on disaster preparedness and argues that IK is based on the following:

- Observation: people's experience of the local surroundings (history of natural hazards, nature of natural hazards, evolution of social and physical vulnerabilities to natural hazards)
- Anticipation: people's identification and monitoring of environmental indicators (early warning signals, time thresholds, escape route and safe places for humans and cattle, key actors and skills)
- Adaptation: people's access to assets and their ability to learn, self-organise and innovate (human, sociocultural, institutional, financial, natural and physical assets), and

[2] To ensure the use of traditional, indigenous and local knowledge and practices, as appropriate, to complement scientific knowledge in disaster risk assessment and the development and implementation of policies, strategies, plans and programmes of specific sectors, with a cross-sectoral approach, which should be tailored to localities and to the context (UNISDR, 2015).

- Communication: people’s ability to transfer knowledge among themselves and between generations (oral and written communication, early warning systems, other practices)

Mavhura et al. (2013) stated that IK is an invaluable source for communities and and an integral coping or resilience mechanism built over centuries. Through living in hazard prone areas and being exposed to recurrent events, vulnerable communities have developed a range of mechanisms that help them to mitigate the risks, forecast the upcoming disasters and reduce the impacts. This knowledge has been developed and passed on through generations, and is dynamic, complex, continuously changing with socio-economic and environmental pressures, determined by spatial and temporal context, is non-formal and not documented, orally transmitted, and based on adaptation and experimentation (Dekens 2007: Shaw et al., 2009). It is a basis for local-level decision making in many communities (Tran et al. 2009).

Importance of integrating IK in development and DRR work at community levels cannot be overemphasized. Community-based disaster risk reduction (CB-DRR), as a predominant approach led and implemented by NGOs in developing world, is built on a premise of incorporating local perspectives and delivering solutions that are locally accepted and sustainable. CB-DRR is built on the idea of participation. However, as Maskrey (2011) argues, CB-DRR is very often done ‘at’ community level, rather than ‘with’ communities. Hence, CB-DRR initiatives tend to be short-lived and lack sustainability. While evaluating community-based flood risk management in the Lower Shire Valley (i.e. case study of this report), Šakić Trogrlić et al. (2018) identified lack of sustainability as one of the major challenges of the existing CB-DRR system in Malawi. Furthermore, same research identified a lack of integration of the rich IK possessed by rural communities. This lack of integration presents a missed opportunity, since reviewed literature points out numerous benefits of using IK for DRR, some of which are improved project performance, community acceptance, cost-effectiveness in the long-term, sense of ownership, and project sustainability (Dekens, 2007; Kniveton et al. 2015). Since IK is embedded in the culture and local way of living, it is especially useful for low magnitude recurring disasters (Tran et al. 2009). Hence, the advent of climate change and its influence on increased frequency and magnitude of hydro-meteorological hazards (considered in this study), presents a threat to IK, since it is out of the lived experience of communities at risk (Mercer et al. 2010). The former, combined with process of globalisation and some of the inherent characteristics of IK systems (e.g. not documented and mainly held by the elderly community members) pose an unseen challenge for the future of IK.

An increasing debate in the mainstream research on IK for DRR is the integration of IK and scientific knowledge, even though authors as Agrawal (1995, p. 433) point out that the divide between scientific (i.e. ‘Western’) and IK is ‘potentially ridiculous’ and a conversation should be tailored towards understanding the multiple domains and types of knowledges. Nevertheless, an increasing number of researchers calls for the integration of indigenous and scientific knowledge, and argue that before IK can be used in policies and practices related to DRR, it first has to be integrated with science (Hiwasaki et al. 2014). These studies are especially relevant in the light of early warning systems, with a growing evidence on the lack of uptake of official warning information about the climate and weather by rural communities. Kniveton et al. (2015) argue that both scientific and IK systems on weather and climate are based on the appreciation of the inherent uncertainty of the information itself, and indicate that integration of the two knowledge systems can enhance the success of the people-centred early warning systems. The way on how best to do achieve the integration is however, an under-researched area. It is therefore important to emphasize that it is out of the scope of the present study to discuss and create the pathways for the integration. The emphasis is rather on documenting and showcasing the abundance of the existing IK used in flood and drought risk management by the rural communities of the Lower Shire Valley.

2.2 Previous studies on the role of IK in DRR in Malawi

Indigenous knowledge and its' role in DRR, or more specifically, early-warning systems in Malawi has been a subject of several studies. It is important to notice that most previous IK studies of Malawian context have been done as a part of development projects, and as such constitute 'grey' literature in the form of project reports, whilst academic and scientific studies on the topic remain scarce.

Existence and importance of IK as an unconventional and traditional EWS has been acknowledged by a number of studies, all agreeing on its' importance for the local rural communities (e.g. Mwase et al. 2014: Mwale et al. 2015), and as a means to foster technological and socio-economic development of communities at risk (Chiota et al. 2011) . While researching IK and climate change adaptation strategies in agriculture in Chagaka Village in Chikwawa, Nkomwa et al. (2014) found that villagers have relied on IK as a means of adapting to changing local circumstances, and even though some official warning information regarding impending floods and droughts has been provided by the governmental extension services, majority of participants relied and used traditional warning indicators. However, there is increasing evidence that due to climate change and environmental degradation, traditional indicators for predicting climate and weather are found to be less useful; or in some instances, 'literally no longer available in the country' (Chavula, 2013, p. 16). An another threat for IK in Malawi is the fact that this knowledge is not documented, it is mainly held by elderly community members who are passing away or relocating due to climatic shocks, and as such, there is an increasing call for documenting the existing knowledge systems (COOPI, n.d.)

A growing need to document the existing knowledge has been a motivation for most of the previous studies done in Malawi. Predominantly using stakeholder consultation as a methodological approach, the studies have unveiled a number of indicators used by local communities to forecast changes in climate and weather and create a connection with the impending flood or drought. For instance, Chiota et al. (2011) found 22 traditional early warning signs used by communities in Mlolo, Nyachikadza and Ntombosola villages in Chikwawa and Nsanje. These signs were grouped under meteorological (e.g. wind direction) and ecological (e.g. presence of a certain type of animal), and it was found that out of the 22 observed signs, 8 are associated with droughts, 3 with floods and the remaining 11 with seasonal changes in weather. One of the most comprehensive studies on IK systems and practices in a region was done by the Global Water Partnership in South Africa, with Malawi being one of the case studies (excluding Chikwawa and Nsanje Districts) (Chavula, 2013). The study findings indicate that communities use IK mainly for weather prediction (e.g. strong winds and dark clouds, presence of local bird species) and have developed a number of indicators for forecasting floods and droughts in the area (e.g. abundant flowering of mango trees, intense heat in September, frequent occurrence of north-east and north-west winds). Similarly, Nkowa et al. (2014) found a number of traditional indicators used to predict weather events and plan farm activities in Chagaka, Chikwawa (e.g. peculiar sound produced by male goat as an indicator of onset of rains, very high temperatures by mid November as an indicator of drought). A study done by the Italian Agency for Development Cooperation (COOPI, n.d.) took a slightly different approach and categorized IK early warning indicators according to the ones that indicate different scenarios, namely: 1) season start (e.g. trees starting to bud, arrivals of swallows), 2) season quality (e.g. halo around the moon, matombozi caterpillar), 3) rainfall event (e.g. lunar phase, wind direction), and 4) dry spell (e.g. grasshopers).

Even though the majority of studies presented above had a focus on documenting the IK indicators, some have gone a step further and discussed the traditional adaptation practices implemented by local farmers based on the IK signs, emphasizing the potential of the traditional practices for building disaster resilient communities in Malawi. For instance, COOPI (n.d.) identified a number of practices in the field of agriculture, flood management, forestry, coping with hunger and post-harvest management. For instance, in order to improve soil structure and conserve the soil moisture, communities have used a principle of minimum tillage. In terms of flood risk management, communities implemented practices such as raised foundations and owning homes both in upland and lowlands; practices which have increased local coping and adaptation capacities. Similarly, Nkomwa et al. (2014) found that the use of traditional indicators plays an important role in local-level decision making, for instance in relation to the choice of the types of crops and planting time. This study argues that communities are capable of perceiving changes and consequently devising adaptation practices in their agriculture systems based on the changing climate. Despite the availability of the studies discussed in this paragraph, understanding of early action and preparations done by communities due to the availability of their traditional warning systems stays limited. Hence, this presents an opportunity for the present study to fill in this knowledge gap, and describe experiences from the communities consulted for the purpose of producing this report.

Reviewed literature on IK for EWS in Malawi is not without the previously mentioned debate on the need to integrate indigenous and scientific knowledge. The main focus of the study by Chiota et al. (2011) was on the scientific validation of traditional early warning signals for floods and droughts in Nsanje and Chikwawa districts[3]. The results indicated that 2 flood related EWS indicators can be explained by established scientific procedures, while IK drought and weather changes indicators cannot be explained. The study concludes that majority of IK indicators are not reliable, and as such are not suited to act as early warning for droughts and floods. However, authors argue that even though most of the indicators cannot be scientifically proven, rural communities still use them to detect changes in weather and occurrence of natural hazards such as floods and droughts. They propose that the existing IK need to be enhanced with scientific knowledge, refined and repackaged before used. Integration with scientific knowledge has been proposed by others as well. For instance, COOPI (n.d.) calls for a detailed monitoring and verification of the IK sign identified in their study. Nkomwa et al. (2014) argue that IK can contribute to and complement the existing climate and weather information in Malawi, and recommends integration of IK when developing localised strategies and interventions, in risk reduction projects, as well as in climate change adaptation projects. The call for integration in terms of EWS is also evident. In his study on decentralised EWS in Malawi, Chavula (2016) acknowledges and mentions a range of IK EWS indicators, some of which can be explained by scientific approaches. He calls for the integration of official early warning information with unconventional EWS, and recommends collecting, documenting, analysing and

[3] The authors of this report express no stand on validating indigenous knowledge systems with scientific knowledge, and here provide the example strictly in the light of the literature review.

evaluating IK with scientific weather forecasts. As one of the identified gaps in the existing EWS system in Malawi, Chiota et al. (2016) mention limited integration of IK in EWS, and propose an assessment of IK research undertaken and yet again, the integration of IK with scientific knowledge.

2.3 Indigenous knowledge for early warning systems: learning from international experiences

The final section of the reviewed literature will share some light on the role of IK in EWS as seen through the lens of international experiences. This section does not aim to provide a comprehensive overview, but rather offers a glimpse and creates an understanding of how IK is seen as a powerful tool for resilience and development across different geographical contexts.

Iloka (2016) discussed the role of IK in DRR from the African perspective, and the paper argues that mere application of scientific knowledge in Africa did not yield satisfactory results due to exclusion of local perspectives and dynamics. The study recommended integration of IK as a starting point in DRR programming and local policy development. One of the most comprehensive studies in Africa is the United Nations Environment Programme (2008) study on the application of IK in disaster management in Kenya, Swaziland, South Africa and Tanzania. The results indicated that IK served as a valuable tool that enabled communities to develop their own forecasting and early warning systems, and based on these, to develop various coping mechanisms and food management techniques. The examples include observations of the behavior of different animal species (e.g. birds, insects), plants and tree species, meteorological indicators and observation of celestial bodies. Furthermore, studied communities have developed mechanisms to interpret and disseminate IK EWS signs. For instance, in Kenya, communities have established councils of elderly people in the community, who interpret the indicators and advise action in the light of the upcoming season. The findings of the study indicate that IK is in danger of being lost due to the lack of documentation, and recommend integration of IK into national development plans and school curricula, whilst significant efforts should be undertaken in coupling scientific and indigenous knowledge. An another notable piece of research was conducted by Lunga (2015), exploring the inclusion of IK into DRR policy in Zimbabwe. This research, spanning across 4 districts, notes that communities use an array of plant and animals to develop indicators for upcoming disasters. These indicators allow the communities at risk to take precautionary action before disaster strikes. For instance, if environmental indicators are interpreted as a season with poor rain, the communities will grow drought resistant crops and save fruits to avoid impacts of the expected famine (Lunga, 2016). The research by Lunga (2015) also makes an attempt in proposing how IK could be mainstreamed into DRR policy. For that, a framework of a broader education strategy is used (i.e. inclusion of IK in education from primary school to university education levels). Furthermore, the study suggested that pathways for including IK in a larger DRR strategic development are through decentralisation, partnerships or devolution.

The role of IK in DRR has best been researched and documented in Asian context. For instance, study by Acharya and Poddar (2016) on IK for flood forecasting in the Gandaki River Basin in India documented methods used by local communities in floods and heavy rainfall forecasting and found that communities are not just consumers, but rather producers of information on weather and climate. A vast array of IK for flood forecasting has been classified as phenomenological (i.e. seeing, hearing, feeling), ecological (i.e.non-human behaviour), riverine (i.e. river behaviour related), meteorological (i.e. wind, cloud and rain patterns), celestial, official (i.e. information provided by government), and triangulating indicators (i.e. knowledge produced through interaction of categories). The study argues how dynamics and adaptiveness of IK is one of its main characteristics, through proving how flood affected communities continue to adapt and develop their practical knowledge. However, one of the main contributions of the study is stating how knowledge systems at the local levels are highly influenced by modern technologies, and in turn, they adapt and change. Discussing the role of increasing penetration of cellular technologies in rural communities in India, the study sees an opportunity in enhancing early warning message communication through coupling modern ways (i.e, mobile phones) with enhancing local knowledge systems for flood forecasting. An another comprehensive study in Asian context has been conducted by UNESCO (2014) where IK for DRR has been researched in coastal and small island communities in Indonesia, the Philippines and Timor-Leste. Next to documenting IK used for disaster forecasting, such as observation of animal behaviour, celestial bodies, the natural environment, and material culture used for prediction, response and recovery; the study discussed the steps through which IK can be coupled with scientific knowledge. The former can be achieved by using participatory processes usually applied through community-based disaster risk reduction interventions. Vulnerable communities, as holders of the knowledge, should be involved in identifying and agreeing on the most useful of IK indicators, that would then be presented to scientists for providing a scientific explanation. Finally, a two-loops learning process can be employed through which communities will receive and give final inputs into the process, but also will benefit from learning some of the scientific principles. The designed process has been presented as a tool entitled LIVE Scientific Knowledge, a community tool for integrating science with local and indigenous knowledge. Asian experiences also offer further interesting lessons in terms of examples of integration between much mentioned integration of scientific and indigenous knowledge. For instance, Victoria (2008) discusses a case from the Dagupan City in the Philippines, where a scientifically established procedure of using staff gauges and flood markers as a part of the official EWS has been complemented by traditionally used bamboo instrument for dissemination of early warning message.

The short overview of international experiences offers two important lessons for the study of IK in Malawi. Firstly, it indicates that the different categories of IK for EWS found across different geographical contexts resemble those that were identified through literature in Malawi. Secondly, it proved that the debate on IK and a need for its integration with official warning systems is an ongoing debate. Thus, the users of the report will be able to contextualize experiences from Malawi with an on-going debate on the topic.

3 Methodology

3.1 Introduction of the case study: The Lower Shire Valley

The case study areas of the present study are Chikwawa and Nsanje districts, that together form the Lower Shire Valley in the southern part of Malawi. These district were chosen due being one of the focus areas of the overall EU ECHO project *Enhancing resilience of vulnerable communities and* *building institutional disaster response capacity in Phalombe, Thyolo, Chikwawa and Nsanje*, and due to being the most disaster prone area in the country. In the Lower Shire Valley, floods, dry spells and droughts, among other hazards, present a serious threat to people's livelihoods, and affect income generated by the rain-fed agriculture. The projected population in 2016 for Chikwawa and Nsanje was 549,706 and 288,581 respectively, with a mean household size of 4.3 in both districts (NSO,2017). Literacy rates in the districts are low, with the latest data indicating the literacy rate for population aged 15 years and above at 59.9% for Chikwawa and 58.1% for Nsanje (NSO, 2017). In the Lower Shire Valley, a percent of households engaged in agricultural activities is 85.7 % for Chikwawa and 89.3 % for Nsanje, with maize, pigeon peas, nuts, beans, soya beans and rice being the main sorts, and average cultivates area in acres being 1.7 in Chikwawa and 1.3 in Nsanje (NSO, 2017). According to the latest available data by the National Statistics Office, proportion of households that is involved in operating non-farm enterprises is 28.2% in Chikwawa and 31.4% in Nsanje (NSO,2017). Examples include traders, other small businesses, manufacturers and other.

With Chikwawa and Nsanje being the poorest districts in the country, the combined effect floods, dry spells and droughts perpetuates the disaster-poverty cycle. Out of the proportion of population that reported not having enough food in the 12 months preceding the 4th Integrated Household Survey, 45.1% and 96.5%, in Chikwawa and Nsanje, respectively, reported that it is due to drought, poor rains, floods or water logging (NSO, 2017). In recent history, the Lower Shire Valley was hit by unprecedented flooding in January 2015 and a prolonged dry-spell in 2016, both events declared as a state of national emergency. Figure 2 gives an overview of the flood[4] and drought risk[5] based on historical analysis.

[4] To identify flood moments in Malawi Landsat imagery was studied (1984-2017). Floods were clearly evidenced in 9 dates. For the clearest and most representative layers the mNDWI (modified Normalized Water Index) was calculated. The index mNDWI (McFeeters 1996; Xu 2006) for Landsat bands is calculated as follows: (b2GREEN-b7MIRSWIR/b2GREEN+b7MIRSWIR). In this variation of the index the higher values are the wettest. A threshold was applied to the mNDWI to separate flood from non-flood or water from non-water pixels. The resulting layers were aggregated and the final stretched from 0-10, where 0 are the pixels where no flood is expected while pixels with 10 are where most frequent flood has been evidenced and therefore expected. The largest flood was observed in 2015, as the scenes were cloudy the flood extent was manually interpreted from several scenes. The evidenced flood dates are: 29 Feb. 1988 low flood, 19 march 1989, 17 march 1997, Feb 1998, March 1999 low flood, 2001 since February 16 until end of April, 2007 17 February since early Feb., 2008 Feb. medium flood, 2015 January – March. The water bodies in this layer are not represented and have a value of 0 like the rest of land where flood is absent.

[5] The drought risk map was created by analyzing rainfall data in the past 20 years using standard precipitation index (SPI) , which is a widely used index in drought analysis. Based on SPI6 values for the period October-march, which is the main rainy season in Malawi. Each pixel is classified to drought or no drought for each year based on SPI6 values, drought year if SPI value for a pixel is less than -1. Next, relative frequency is calculated, the number of times drought has occurred in the considered 20 year period. This frequency is then converted to probability of drought occurrence in a given year. We validated our analysis by comparing NDVI values for the drought year against long term average values.

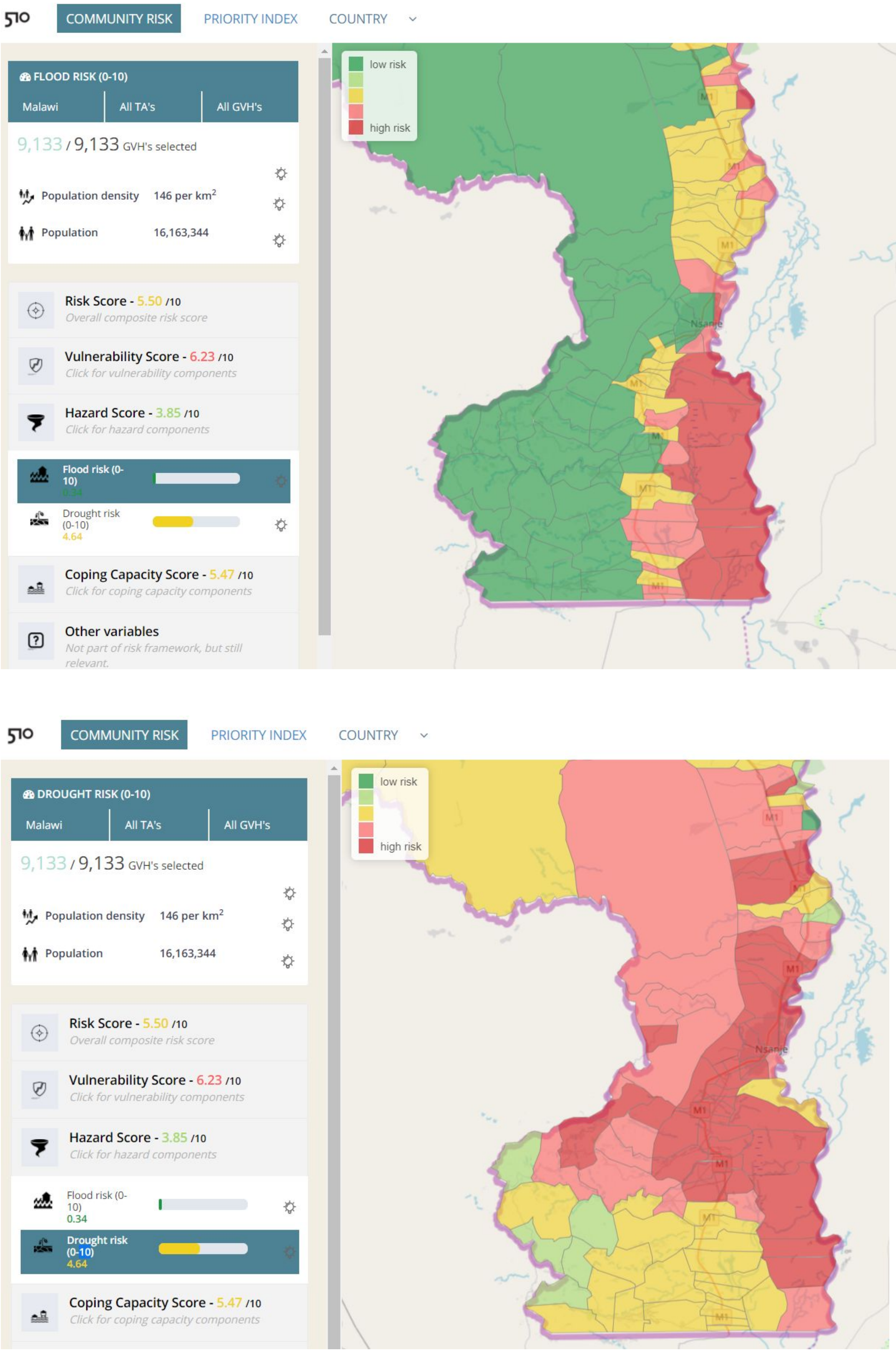


Figure 2 Overview of the flood risk (top) and the drought risk (bottom) in Nsanje and Chikwawa. Source Dashboard 510,

The hydrology of the Lower Shire Valley is dominated by the Shire River, the only outlet of the Lake Malawi and one of the crucial tributaries to the Zambezi River. In addition to the Shire River, flooding in the region is caused by the flash flooding of the Ruo River and a dense network of smaller streams, that flash flood in the rainy season, mainly caused by the rainfall falling in the upper districts. Floods are occuring on an annual basis. The floods risk in the region is a combination of the hazard characteristics (e.g. location, high levels of siltation, land use change, deforestation) and contributing vulnerability factors (e.g. socio-economic and environmental susceptibility) (Mwale et al. 2015). Previous studies on droughts and dry-spells in the Lower Shire Valley are limited. Prolonged dry-spells occur in the rainy season, in the months from December to February, and lead to reduced crop yields, lack of accessibility to safe water sources and scarcity of land for animal grazing (Nsanje District Council, 2015). Due to the high dependence on rain-fed agriculture, prolonged dry-spell impacts in the region have resulted several times in serious humanitarian crisis (Chikwawa District Council, 2014).

Due to the frequent occurrence of flooding and prolonged dry-spell and its' adverse impacts on local communities, there is a high presence of national and international NGOs and development partners working on disaster risk reduction initiatives, primarily at the community level, in a join effort with the local government.

3.2 Overall approach and data collection activities

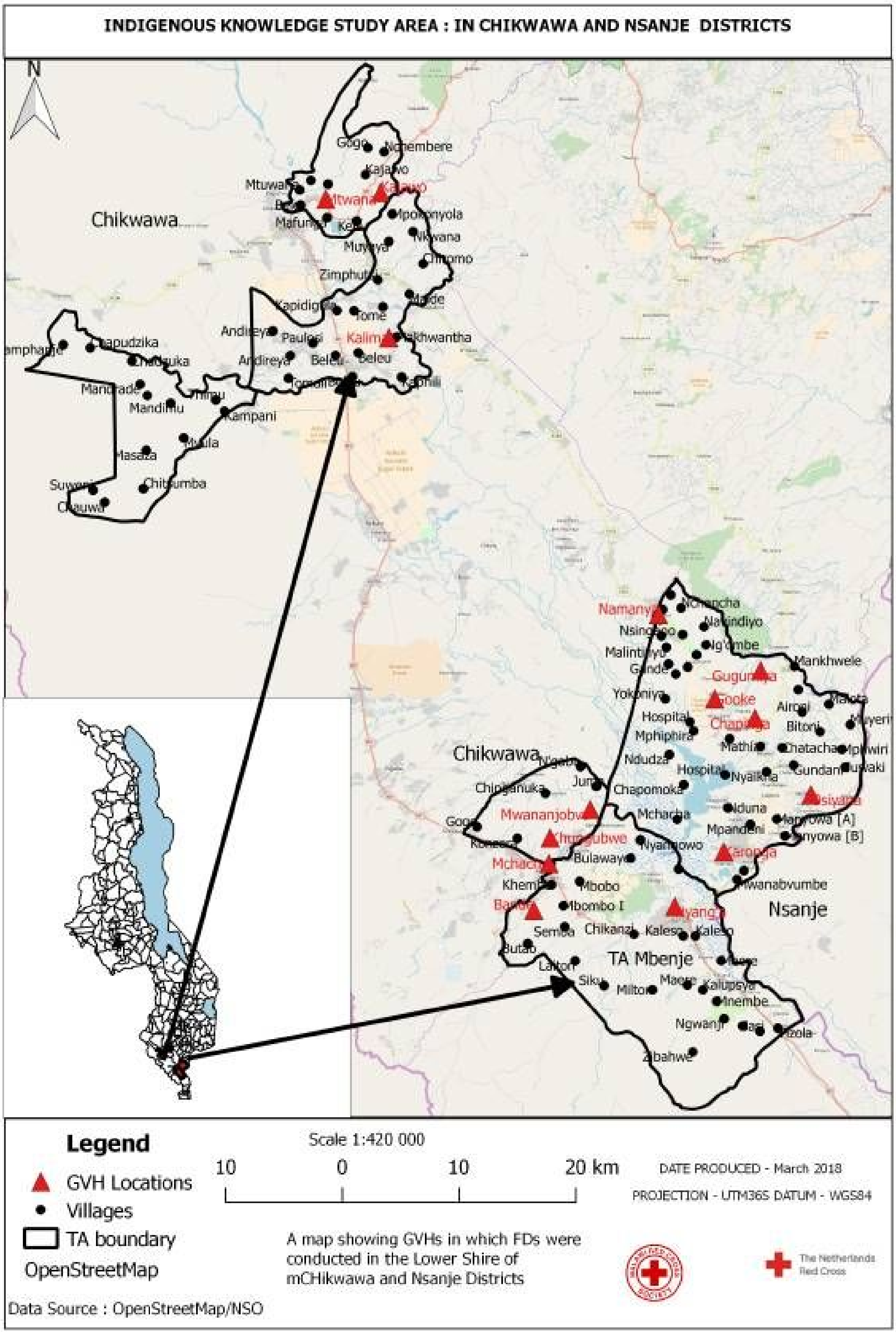
In order to understand and document the indigenous early warning signs for the most common hazards in the Lower Shire Valley and understand the early actions taken by the local communities, the study has taken a qualitative approach. Qualitative research methodologies grant the flexibility to gather and interpret a large amount of in-depth data describing a certain phenomenon, and offer an array of research instruments. ocus group discussions (FGDs) and key informant interviews (KII) were used to gather a large amount of high-quality primary data in a relatively short time frame representative of asignificant number of research participants.

The present study is based on the findings generated by data collected in 17 GVH's (Group Village Heads) across 6 TA's (Traditional Authorities) in Chikwawa (4 TA's) and Nsanje (2 TA's). Specific GVHs were selected as being a part of the ECHO project, and were all assessed as being prone to floods and prolonged dry-spells. Table XY provides a detailed overview of the case study areas and data collection activities undertaken.

Table XY: Overview of case study areas and research instruments used

District	**TA**	**GVH**	**Number of Focus Group Discussions**	**Number of Key Informant Interviews**
Chikwawa	Chapananga	Lundu	1	1
		Tiyimbe nawo	2	1
	Ngowe	Mwananjovu	2	2
		Mchacha	2	1
		Khungubwe	2	1
	Mlilima	Mtwana	2	1
		Kajawo	2	1
	Maseya	Kalima	1	1
Nsanje	Mbenje	Nyang'a	2	2
		Bande	1	2
		Kamanga	2	1
	Mlolo	Gooke	2	2
		Namanya	2	2
		Gugumiya	2	2
		Karonga	2	1
		Osiyana	2	2
		Chapinga	2	2
TOTAL	**6**	**17**	**31**	**25**

Figure XY shows the GVH locations on the map, except for the locations of the following three GVHs: Lundu and Tiyambe nawo (TA chapananga), Kamanga (TA mbanje). A GVH consists of several villages and the precise village in which the FGD and KII were done could not be identified.



INDIGENOUS KNOWLEDGE STUDY AREA : IN CHIKWAWA AND NSANJE DISTRICTS
N
Chikwawa
Chikwawa
Nsanje
TA Mbenje
Legend
GVH Locations
Villages
TA boundary
OpenStreetMap
Scale 1:420 000
10
0
10
20 km
DATE PRODUCED - March 2018
PROJECTION - UTM36S DATUM - WGS84
A map showing GVHs in which FDs were conducted in the Lower Shire of mCHikwawa and Nsanje Districts
Data Source : OpenStreetMap/NSO

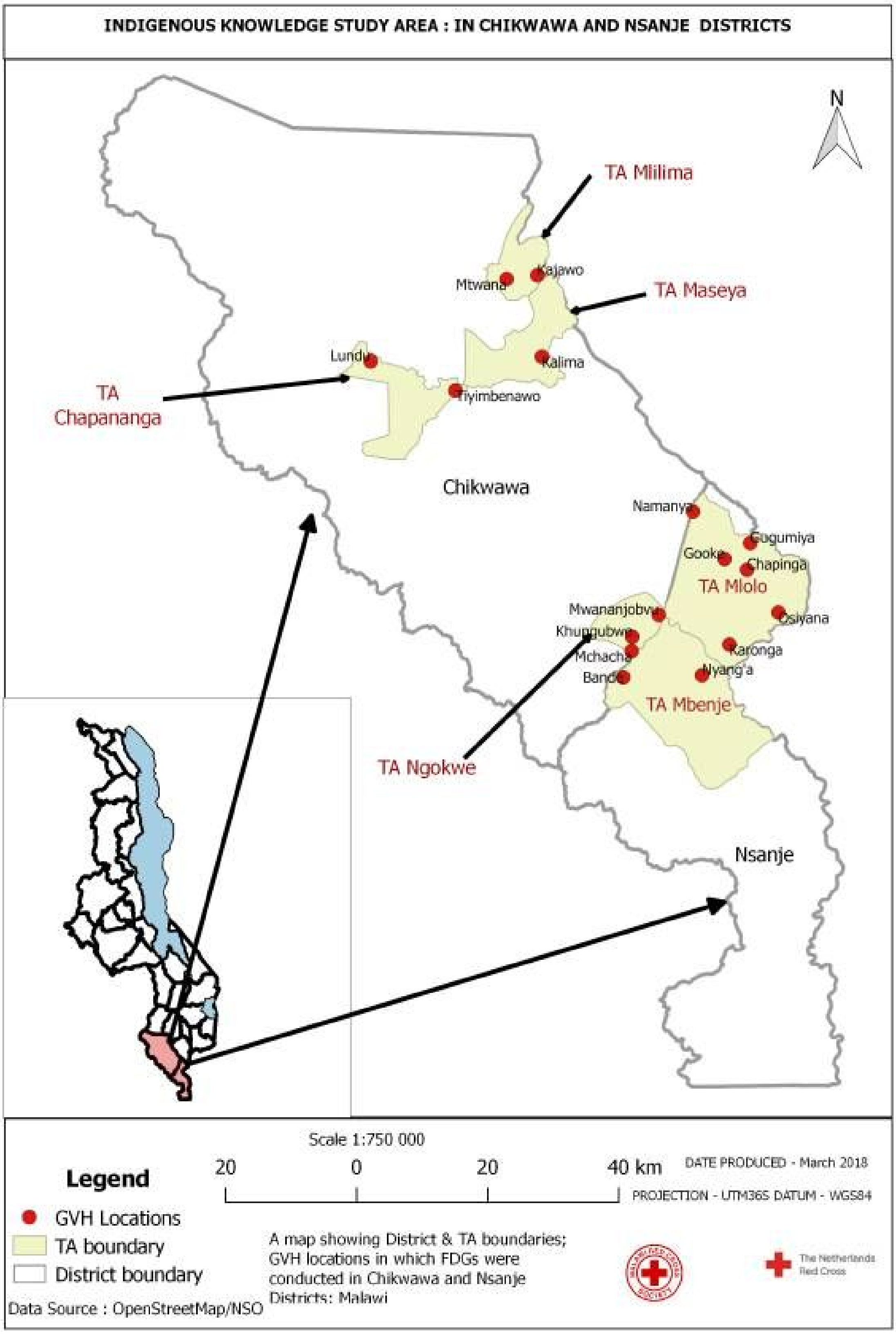


Figure XY Map of the GVH locations. 510 Simon Tembo

Taking into account the cultural setting in Malawi and experiences from previous work, the research designed envisioned two, gender-seperated FGDs in each GVH, followed by the KII with individuals. Prior to conducting FGDs and KII, the participants were fully informed by facilitators of the study objectives and ways in which results will be used (i.e. both for project and academic purposes). The research participants were selected using the purposive sampling approach (i.e. study participants selected based on a certain set of criteria), after the consultation with the community-leaders (e.g. village chiefs) who helped with reaching out to the individuals. Participants in FGDs were selected based on the following criteria:

- Living in the village for most of their lives
- Over the age of 55 (for most of the participants), and no upper age limit
- Up to 2 participants from a different age category, know to be affected by flooding
- Extensive experience with flooding (i.e. preferably living in the lowlands[6])
- Known in the community for having IK related to disasters

Overall, 31 FGDs have been conducted (14 FGDs with male and 17 FGDs with female participants, totaling 97 male and 92 female participants). The FGDs took place in community-spaces (e.g. beneath the trees usually used for community meetings, evacuation structures). Due to logistical constraints, it was not possible to conduct both male and female FGDs in each of the GVHs, as initially planned. However, as the sample of conducted FGDs represents a rather large sample for a qualitative study, the above mentioned omission does not seriously influence the validity of the study, and allows for data saturation to be reached. The duration of the FGDs and KII was approximately one and two hours, respectively. The majority of the participants in the FGDs were subsistence farmers with only a few fishermen and small business owners, and fall into the age category presented in the Figure XY. Approximately, 55% is 56 years or older.

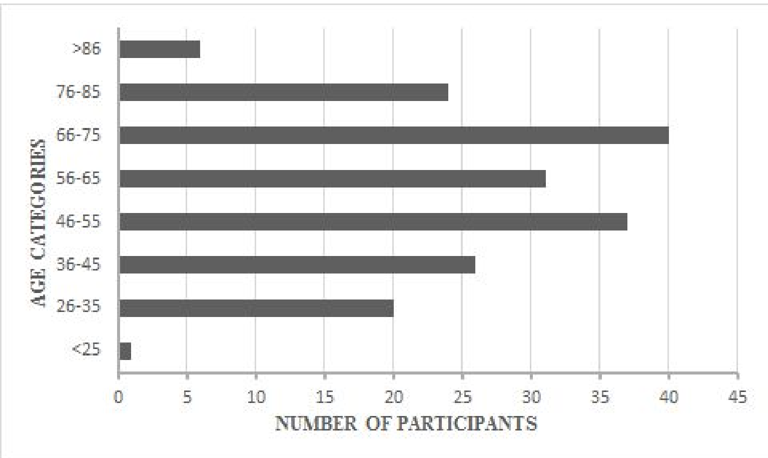


Figure XY: Age categories of the FGD participants

In addition to the FGDs, 25 KII were conducted. For the KII, target participants have been community leaders (i.e. GVH chiefs), and members of the Village Civil Protection Committee (VCPC). These individuals were selected due to specific roles they have in terms of warning message dissemination and overall involvement in DRR activities.

[6] Drought and prolonged dry-spells will be occurring both in high- and lowlands, whereby droughts in highlands can be more severe as there will be less residual moisture.

Figure XY: Example data collection activities

The question guides used for FGDs and KII were created based on the literature review and designed to cover following topics: 1) an overview of the flooding, drought and dry spell situation in communities, 2) indigenous early warning indicators for floods, droughts and dry-spells, 3) action taken based on IK signs and systems for message sharing, 4) reliability of indigenous warning, and 5) accessibility to official warning information. Table XY shows a high level overview of the topics. Detailed list of questions and prompts used in the study can be found in the Appendix 1.

Table XY Overview of topics for the Focus Group Discussions and the Key Informant Interviews.

Topic Area	Time to be allocated
Floods	50%
Overview of the flooding situation in the community	
Indigenous early warning for flooding	
Part 1 Before the flood (few months to a week before the flooding event)	
Indigenous early warning indicators	
Actions taken and systems for message sharing	
Part 2 Immediately before the flood (a week before the flooding event to the actual flooding event)	
Indigenous early warning indicators	
Actions taken and systems for message sharing	
Drought and dry spell	40%
Overview of the drought and dry spell situation in the community	
Indigenous early warning for drought	
Indigenous early warning indicators	
Actions taken and systems for message sharing	
Indigenous early warning for dry spell	
Indigenous early warning indicators	
Actions taken and systems for message sharing	
Reliability of indigenous warning	5%
Accessibility to offical early warning information	5%

The data collection activities were undertaken by the team of facilitators (both male and female) from the Malawi Red Cross, most of them with college background and a good level of both English and Chichewa. Prior to data collection activities (September and October 2017), facilitators were trained by the authors of this report and provided with the data collection guides. All FGDs and KII were conducted in Chichewa, recorded, and transcribed for the later analysis.

3.3 Data analysis

The collected data were analysed using the thematic analysis, one of the most common approaches to data analysis in qualitative research. The thematic analysis is based on a process in which collected data is thoroughly examined for identifying recurring themes in the text. Initially, data was coded (i.e. assigning a code to a specific portion of text) by the authors of the report, followed by the process in which codes were merged into themes of interest. After the iterative process of coding and theme identification, the final reporting and findings write-up were done. In this process, general themes were generated based on the themes covered in the interview guides, and a coding scheme has been developed (Appendix XY), and applied to data transcripts. Since the qualitative data set sampled in this study was a rather large one and there were no significant differences in ecological, meteorological, riverine and cultural context between the GVHs, it was noted that the data saturation has been reached (i.e. after a certain number of interviews and FGDs, no new relevant data was being produced). During the report writing phase, participants quotations have been used in order to fully depict the in-depth information gathered and provided contextualised results. Even though it would contribute to the overall validation of the produced results, due to logistical constraints, there was no opportunity for participants to provide feedback on the findings.

4 Results: indigenous early warning for floods and droughts in the Lower Shire Valley

4.1 Indigenous knowledge and flooding

4.1.1 Overview of flooding situation in case study areas

4.1.1.1 Flood frequency

Communities in the Lower Shire Valley are exposed to frequent flood events, with frequency ranging from annual flooding to once in every few years. The timing of flooding was unanimous across the case study communities: floods occur during rainy season, starting from the end of December and on-going until March. There were two main types of flooding noted: riverine flooding from major rivers (Shire River, Mwanza), and flash flooding occurring in minor streams. Communities demonstrated awareness of the causes of flooding, indicating that floods in the villages are shaped by the interplay between heavy rainfall, low-lying topography and increased rates of deforestation. In addition, it was noted that those living in the lowlands are most exposed to flood events.

Eliciting information of the major flooding events from affected communities can serve as a valuable source of data in data scarce countries such as Malawi. Research participants recalled major flooding events in their respective villages, with major floods happening in 1967, 1982, 1987, 1989, 1991, 1997, 1999, 2001, 2009, 2013, culminating with the major flood in 2015. The 2015 flooding put Malawi in the headlines of international news, with bringing devastating effects in the Lower Shire Valley (example flood extents in January 2015 presented in Figure XY). Next to major flooding events that imprint into community members memories, there are smaller annual flooding events that are not necessarily seen through a 'negative' lens, since floods of smaller frequency provide farms with residual moisture, thus supporting sustainable livelihoods.

'*In 1989 there were heavy floods that destroyed even lives. From there, we only had flash floods until 1996 where we experienced heavy floods. There were flash floods again up until 2002, 2003 and 2004 where there were heavy floods as well. It happened again in 2006, 2009 and then 2015. In 2015 it was so heavy that even the elderly in our community had never seen such*' (KII, GVH Osiyana)

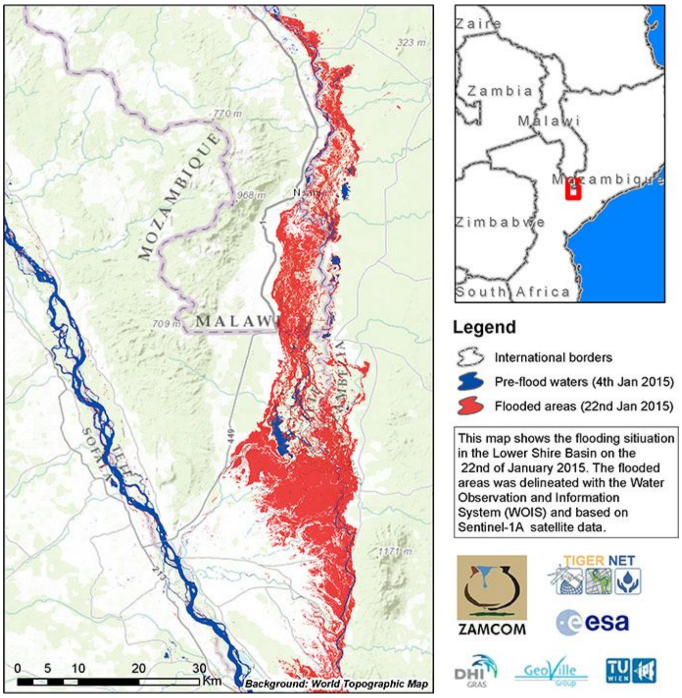


Figure XY: Satellite image of flood extents during January 2015 flooding (image curtosy of DHI, 2015)[7]

4.1.1.2 Flood impacts

The livelihoods of communities in the Lower Shire Valley are closely tied with agriculture, with majority of population being subsistence farmers, with limited access to job opportunities. Thus, the analysis of flood impacts on communities needs to go beyond mere expression of losses in monetary terms towards taking a multi-dimensional lens. Impacts can be seen as both direct (i.e. due to the direct contact with water), indirect (i.e. no direct contact with water), tangible (i.e. can be expressed in monetary terms), and intangible (i.e. can't be expressed in monetary terms).

[7] http://www.dhi-gras.com/news/2015/1/29/malawi-and-mozambique-floods-captured-from-space

As depicted in Figure XY, flooding has adverse impacts on communities in the Lower Shire Valley. Livelihoods are affected through floods washing away crops, livestock and soil erosion and siltation that can lead to soils losing function as agricultural land. Peoples' houses are washed away by flooding waters or collapse due to heavy rainfall. Since large percentages of case study communities live below poverty line, they lack resources to effectively bounce back on their own. Furthermore, floods leads to the disruption to school services, access to health-care facilities, abrupt interruption to transportation network, and damage to sanitation facilities and boreholes. Increases in public health incidents always follow major flood events, with increases in malaria, cholera and diarrhea. Finally, floods affect cultural values of communities, with some examples being separation of families for longer periods and damages to graveyards in the villages.

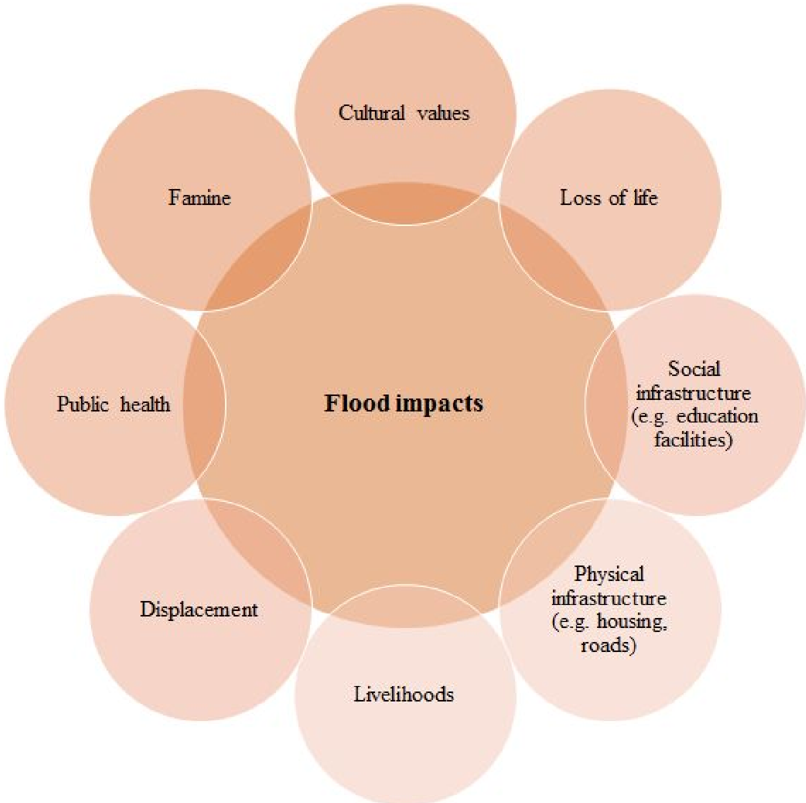


Figure XY: Flood impacts on communities in the Lower Shire Valley

4.1.2 Indigenous early warning indicators for flooding

During the data collection, FGD participants and interviewees provided a vast number of indicators that are seen in a community as an indigenous flood forecasting sign of an upcoming event. Following the findings from the literature review, it was apparent that indicators are locally-bound and case-specific. However, it was noticed that most of the indicators, even though different between consulted communities, were similar in the sense that they stem from the communities close relationship to the surrounding environment and similar agricultural practices. Available flood forecasting signs are observed through the specific behaviour of locally available plants and animals, changes in the river behaviour, monitoring of the weather and temperature changes, and through the nature of the behaviour of celestial bodies. Importantly, a large number of the observed signs is related to the villagers forecasting the occurrence of rainfall, once again depicting a clear path through which indigenous knowledge is integrated into the everyday livelihood of people. With majority of population in the case study areas being subsistence farmers, in the absence of widespread availability of irrigation farming, amount and distribution of rainfall conditions the yields in the farms, and hence availability of the food for people.

With an array of available indigenous flood forecasting indicators, it was needed to create a meaningful classification, in order to present results in a coherent manner and create a simple, but yet comprehensive overview of indigenous warning practices in the case study communities. As demonstrated in the literature review section, previous study have made proposed different classifications of the indigenous knowledge for EWS. In this study, a classification developed by Acharya and Poddar (2016) was used, with documented indigenous flood forecasting indicators being grouped into 4 main categories:

- **Ecological**: behaviours, phenomena and patterns that are not related to human behaviour
- **Riverine**: behaviour of the waters in the river
- **Meteorological**: encompasses wind movements, rains pattern, temperature and clouds
- **Celestial**: related to behaviour of celestial bodies (e.g. sun, moon, stars)

The original classification was contextualised during analysis according to the data collected[8]. In Table XY, an overview of the indigenous flood forecasting indicators in the case study areas, according to the used classification, is presented. Due to a large number of documented indicators, the table provides only examples, to create an overall image of what is available, together with the indicator period of occurrence. A detailed explanation of the specific categories is provided in the remainder of this section. In addition, Appendix XY presents tables providing detailed information on all indicators documented during the data collection period .

Table XY: Overview of the indigenous flood forecasting indicators in the case study communities

Indigenous flood forecasting categories	**Example indicators**		**Indicated period of occurrence**	
Ecological	**Animal behaviour**	**Plants behaviour**	**Animals**	**Plants**
	Abundance of ants ('*nyerere*') in the village	Increased flowering of the '*Mkhunku*' (Acacia Nigrescens) tree	August to December	August to November

[8] The original classification proposed by Acharya and Poddar (2016) contains in total 7 categories, as opposed to four categories used to document indigenous flood forecasting indicators in this study. The reasons for this difference are twofold. Firstly, a category of 'phenomenological' indicators was not found applicable in the light of the collected data. This category is rather found as an integral part of other categories (e.g. people 'feeling' the heat). Secondly, the categories 'official' and 'triangulating' indicators were not used to the objectives of the present study. As opposed to designed study, Acharya and Paddars (2016) objectives were broader, in terms of looking at the interaction between indigenous and official early warning system.

	Hippo ('*mvu*') migration from the river banks to villages	Increased production of fruits of the 'Mbwemba' (Adansonia) tree	October to December	August to December
	Increased numbers of local bird species (e.g. '*anazeze*', '*songwe*')	Increased flowering of the 'N*kuyu*' (Ficus) tree	July to January	August to December
	Fisherman observe increased number of fish ('*somba*') in the rivers	Increased production of fruits of the 'Magwafa' (Psidium guajava' tree	December and January	September to December
Meteorological	Extremely hot temperatures ('*ng'amba*')		October to January	
	Rainfall intensity		October to March	
	Occurrence of dark clouds ('*mitambo yakunda'*)		November to January	
	Heavy winds ('*mwera*')		October to January	
Riverine	Increased sounds from the waters moving in the river		December to March	
	Colours of water (darker, muddier, increased debris)		December to March	
	Creation of foam in the waters		December to March	
	Waters backflow effects		December to March	
Celestial	Moon with concentric rings ('*Chikwa*')		August to January	
	Orion star occurrence ('*Nthand*a')		October to January	
	Full moon ('*Phanda*')		October to December	
	Brightness of stars ('*Nyenyezi*')		November to December	

During the data collection and analysis, it was noticed that attaching a time-scale (i.e. periods of occurrence) to documented indigenous flood forecasting indicators is not a straightforward process. Due to the location-specific nature of indigenous knowledge, it is evident that even the signs are that are repeatedly reported by different communities and key informants, have a different period of occurrence attached to them. However, it was also evident that the differences are not significant. As previously mentioned, study participants were unanimous on the periods of the year in which they are impacted by flooding (i.e. December - March), and the rainy season in the Lower Shire Valley falls in the period between October/ November to April. Following this, it can be noted that some of the categories of flood forecasting indicators mainly can be observed prior to the flooding season (ecological), some indicate imminent floods (riverine), whilst other are observed across this time spectrum (meteorological and celestial). Figure XY presents an attempt to attach a timeline to different categories of warning indicators. However, it should be noted that this classification is just provisional, whilst a definite division cannot be accomplished (e.g. some of the ecological indicators are observed very close to the actual time of flooding). The proposed timeline can be of use for external stakeholders working with communities (e.g. NGOs, government sector), with interest in exploring how indigenous early warning systems could be integrated into the existing system.

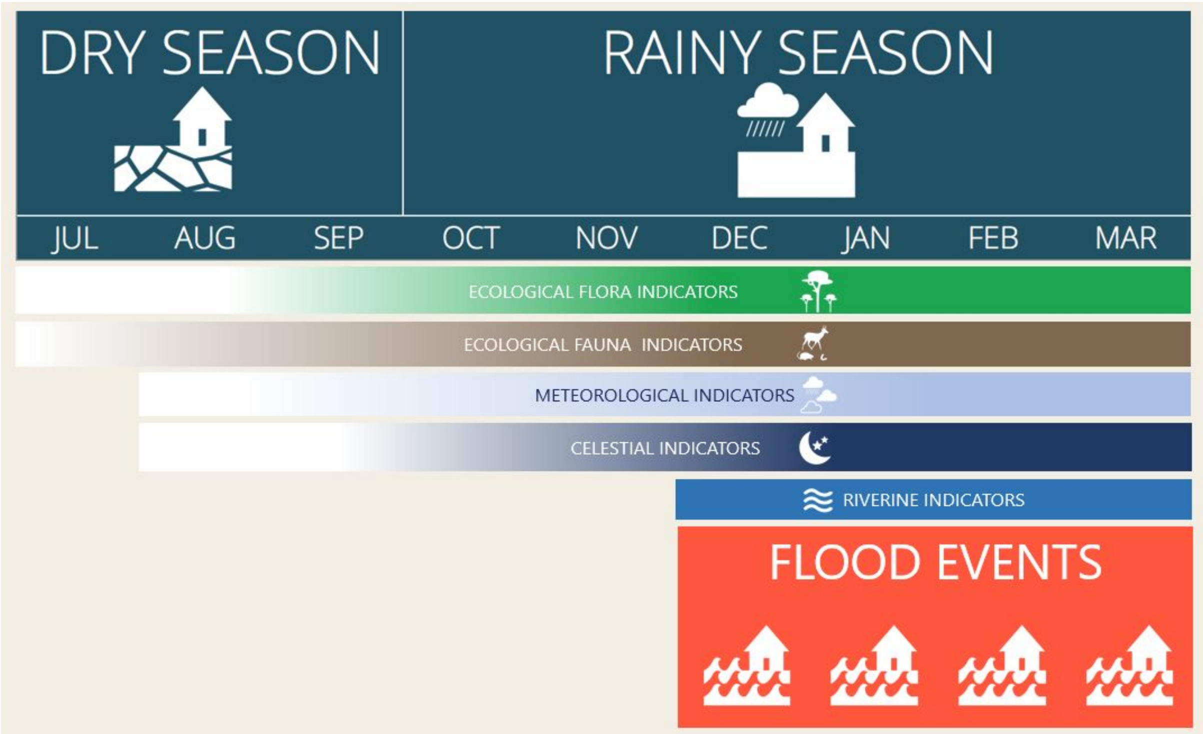


Figure XY: Timeline for documented indigenous flood forecasting indicators[9]

4.1.2.1 Ecological indicators

Across the case study communities, a large number of ecological indicators were documented. The indicators fall into two main categories, namely specific behaviour of animals and changes in plant behaviour. The analysis identified 29 different animal species and 21 plant species (mainly trees). It should be taken into account that in some instances, different communities use different names for the same type of plant or animal (e.g. frogs are locally known as '*thesi*' and '*chule*'), which could have potentially influenced the counting process. Furthermore, in many instances (especially for local bird and tree species) it was not possible for the data collection team to elicit the name of the species in English; which would further lead to identification of scientific terms. However, the former was not possible, and it would require an interdisciplinary team of experts (e.g. including botanists and zoologist).

[9] This figure was created based on the data collected and associated assumptions. The 'flood events' box presents all months in which floods are occuring in the case study communities. Based on this, indicators have been assigned even in the months were they were not explicitly mentioned by communities, but flood events are reported by communities. The brightness of the colour in the figure indicates the increasing certainty of flood event, accompanied by the increased number of indicators.

Ants (locally called '*nyerere*', '*nthendza*', '*agang'a*') were the most common indicator of the heavy rains. Ants start appearing in increased numbers, outside and inside the houses, and the villagers are at unrest, because ants disturb their sleep. Increased number of ants are also found in the farms. In addition to ants, an increased number of insects such as mosquitoes and spiders is observed. Various types of birds (e.g. '*anazeze*', '*akakow*a'), when found in increased numbers of producing a specific, loud sound are seen as indicators of heavy rainfall. Examples of other species of animals indicating a season with heavy rainfall are phytons, grasshopers, rats, cats etc. An interesting example of the hippo ('mvuu') behaviour was reported in several villages. Hippoes behaviour indicates not only the heavy rains and upcoming floods, but serves as an indication of the flood extent. As presented by a male FGD participant from Ny'anga

'*The hippo will move away from the water and walk for more than a kilometer on dry lands. These animals also give us an understanding on how the floods will behave. Every place where the hippo passes through, it is exactly the place where the floods will reach. Where the hippo did not go, the floods will not reach those land*s'.

Most of the indicators from the above provided examples have a longer lead time before the rainfall event that will be seen as a triggering mechanism for floods. Communities notice some of these occurrences already from July, all the way to the flooding season. In addition to the longer term indicators, examples of animal behaviour that indicate upcoming heavy rainfall or flood were discussed. For instance, ducks ('*bakha*') raise their wings and want to be in the waters, fishermans observe and catch more fish ('*somba*') than usual, and cattle ('*ng'omba*') shows signs of excitement.

Various species of trees were documented as another important ecological indicator, found across visited communities, serving as indication of the heavy rainfall expected in the upcoming season. Communities see trees as giving a longer term information, since changes in trees are observed starting from July and into the flooding season. There were two main patterns indicated, namely increased number of fruits (e.g. in '*mtondo*', '*magwafa*', and '*nyenza*' trees), and abundant flowering of trees (e.g. in '*mhkunku*', '*nkuyu*', and '*mkotamo*' trees).

4.1.2.2 Meteorological indicators

Meteorological flood forecasting indicators in the case study communities are primarily concerned with observing the changes in temperatures, rainfall patterns and intensity and specific blowing of winds. As previously stated, indicators that forecast heavy rainfall are seen also through a lens of causing flooding and associated impacts on livelihoods. Meteorological indicators exhibit both seasonal (i.e. forecasting heavy rainfalls in the season) and more immediate character (i.e. upcoming flooding).

Very hot temperatures ('*ng'amb*a') starting from October and leading up to a flooding season were mentioned as one of the predominant indicators. Some villagers pointed out that in this period people sleep outside, and are uncomfortable. Study participants directly correlated higher temperatures to higher rainfall amounts. Heavy blowing of winds ('*mphepo*', '*bangula*' or '*mwera*'), causing damages to homes (e.g. damage to roofs) in flooding season was also documented. Furthermore, wind direction (both southern and northern winds, depending on the community) was also indicated as a sign of more imminent indicator of heavy rains and floods. Additionally, meteorological indicators of heavy fog in the mountains (‘*nkhungu*’), appearance of dark clouds (‘*mitamo yakunda*’), and increased whirlwinds (‘*kavuluvul*a’) were reported.

Monitoring the local rainfall patterns and intensity emerged as a major meteorological flood forecasting indicator. As narrated by the key informant interviewee from Khungubwe: ‘*For floods we do not focus on the cloud or wind but on the intensity of the rain*’. Study participants pointed out that rainfall intensity indicated the upcoming flood, because the rain will be falling for several consecutive days before it floods. It should be noted that villagers pointed out that flooding in their communities sometimes occurs in the absence of localised rainfall, and it cause by rains in the upper parts. Changes in rainfall are closely observed by communities, in order to increase the overall preparedness and secure early action. For instance, during the events of heavy rainfall, men will be in charge of monitoring the changes are alerting other community members. If they notice heavy rains starting in the morning and continuing throughout the day in the evenings, they will stay awake and monitor the situation. From the former, it can be noticed that rainfall as indication serves a shorter-term sign of the upcoming flood.

4.1.2.3 Riverine indicators

The study from Acharya and Poddar (2016) found that riverine indicators are the most reliable indicator for flood forecasting. Similar conclusions can be drawn for the present study. Using the benefits of residual moisture availability, a large percentage of people farm next to the river banks. Since flooding affects the crops and perpetuates the disaster poverty cycle in the Lower Shire Valley, throughout their close relationship to the running water bodies, people have developed a number of strategies for monitoring the waters and forecasting the upcoming flood. For instance, a key informant from Kalima explained:

‘*The water in the river immediately before the floods is very dirty and they (waters) come along with litter and timber planks and the moment these show up we know it is only a matter of hours before the river overflows*.’.

Villagers indicated that when the flood waters are rising, the sound of water in the river beds in loud. They notice the water levels rapidly increasing and river banks filled until the maximum capacity. Waters are of increased velocity, making it challenging for people to cross the rivers. Presence of debris and waste, muddy colours, foaming of waters and unpleasant odour coming from the river were all documented as signs of an upcoming flood.

4.1.2.4 Celestial indicators

In comparison with other groups of indicators, celestial indicators constituted a smaller group. The timing of the indicators documented spanned from October until the flooding season. In a number of communities, concentric rings around the moon (‘*chikwa*’ or ‘*nkhokwe*’), are seen as a sign of heavy rainfall and bumper harvest. A full-moon (‘phanda’) in a period from October to December indicates rains, and participants described that the full moon is surrounded by stars that ‘fall across each other’ in the east-west direction. The direction of the rising of the moon is also being interpreted; moon rising from the south is a sign of heavy rainfall in the season. The appearance of bright stars (‘*nyenyezi*’) in groups, the ‘redness’ of Sun (‘*dzuw*a’) are also seen as indications of a rainy season, appearing in a period from October to November.

4.2 Indigenous knowledge, droughts and dry spells

4.2.1 Overview of drought and dry spell situation in case study areas

4.2.1.1 Drought frequency, extreme events and duration

Community members could not make a clear-cut distinction between droughts and dry spell and the terminology was once in a while used interchangeable, but overall “dry spells” were taken as relatively short periods of droughts (up to approximately three weeks) and “droughts” as prolonged periods (up to the entire rainy season). Several communities used as a way to demarcate dry spells from droughts the impact; in case of dry spells there was still something to eat as some soil moisture remains, in case of droughts there is acute food insecurity. Nearly all communities stated that they experience dry spells every year in the rainy season. For example, the rainy season can start well, but towards January or February the rains completely disappear. Or the rainy season starts late such as at the end of February. Prolonged dry spells resulting in drought of three up to four months occured not annually, but every three to five years. The time when droughts start varies although most FGDs mentioned from November or December onwards (but one mentioned from June onwards).

Research participants recalled major events (droughts or extended dry spells) in their villages in 1979, 1980, 1982, 1989, 1991/1992, 1994-1996, 2001, 2002, 2010, 2012, 2015/2016. However, often they also stated that they did not exactly remember or that they forgot. Some went even back to the years of 1948, 1949 and 1951. When they recalled events, they usually directly linked it to how they coped. For example, cultivating in another village in 1994-1996 or receiving food aid, rice from China and maize from Kenya in 1983.

4.2.1.2 Drought and dry spell impacts

As already explained in section 4.1.1.2 for flood impacts, impacts can be direct, indirect, tangible and intangible. Furthermore, impacts can be at community, household or individual level. The European Commission Humanitarian Aid and Civil Protection distinguishes in the working paper on Risk Assessment and Mapping Guidelines for Disaster Management three categories of impacts: human, economic and environmental and social impact. This categorization also captures well the impacts reported by the communities in our study as shown in Table XY.

Table XY Overview of the drought and dry spell impact on communities in the Lower Shire Valley.

Drought impact category	**Drought impact elements**	**Example**
Human impact	Food insecurity	Children get malnourished. People are too weak

		to work even in their garden. People eat nyika from shire river and also sweet potato leaves. People have to go to other districts to buy food such as maize bran. In 1983 dependent on humanitarian aid, rice from China and maize from Kenya.
	Poor sanitation and hygiene	Not washing hands after using the toilet and we mostly don't take a bath
	Disease outbreaks	
	Displacement	
Economic and environmental impact	Agricultural loss	When seeds are sowed in December and it is dry the first few weeks/months, the seeds fail to germinate.
	Agricultural loss	Crops dry up and wilt or get rotten in the ground. Cassava gives lower yields than usually. In case of drought, complete harvest can be lost and no use to plant anything during the entire rainy season; in case of dry spell millet and sorghum can still be harvested.
	Agricultural loss	More insects such as worms come to damage crops.
	Livestock loss	Cattle dies from foot and mouth disease or from thirst.
	Water boreholes	Water table in boreholes lowers and some boreholes dry up.
	Casual work	Men have to search work away from their villages. No casual work available.
		Women resort to sex for food.
Social impact	Social cohesion/family live	Most of the marriages gets disrupted or destroyed, since most women get attracted to those that have food and other resources in their homes.
	Social cohesion/family live	Men have to search work away from their families. Women resort to sex for food. People play more Bawo.
	Education	Children do not go to school.

4.2.2 Indigenous early warning indicators for droughts and dry spells

Table XY below gives an overview of indigenous early warning indicators for droughts and dry spells. One of the FGD mentioned that these early warning indicators are closely related to the ones for floods; that is if the early warning indicators for floods do not occur, the community was confident drought would be coming. In some cases, the description of indicators was conflicting. One FGD mentioned for example that if there was no ring surrounding the moon, droughts would come, whereas another FGD mentioned the opposite. Similarly for the hole of the Spider (Buwe): one FGD mentioned its hole is covered with a web when a drought arrives, the other FGD mentioned it was opening and not sealed.

***Table XY*: Overview of the indigenous drought and dry spell forecasting indicators in the case study communities. In italic the vernacular names are given.**

Indigenous drought and dry spell forecasting categories	Example indicators	Indicated period of occurrence
Ecological	**Plants behaviour**	
	Mfuma and *ntoyo* trees shed all their leaves. Bush grass withers.	
	Increased mangoes, sunbird tree (*mtondo*) fruits and Baobao production.	
	Cassava gives lower yields than usually. Nyika plant.	
Ecological	**Animal behaviour**	
	Birds make a camp there where there is a plot of maize.	September
	Kanyimbi comes out of the bush to villages.	
	Worms (*Anyimbiriko)* seen in *Nyamtombozi* tree.	
	Foxes are moving into the village.	
	The hole of the Spider (*Buwe*) is covered with a web (but opening not sealed according to other) A lot of big tortoise near the river.	
	Antelope come out of the bush and move to villages to drink water.	Starting in July

	Pangolin (*Nkhaka/Khaka*) falls down (meaning this very oily animal that normally lives in a cave comes out during the day. *Kamba* or porcupine *chisoni* falls?.	
	Nkhaka (pangolin	
	Wolves produce funny sounds	
	Bird makes its nest door facing heaven. Unknown (*Mpherenga*) bird comes out.	
	More elegant grasshoppers (*Nabobo)* or bigger grasshoppers (*katchokotcha*), which produces crying sound like "khetchekhetche" audible up to 100 m.	
Meteorological	Fog	September
	Wind blows frequently from all directions (or south to north, especially morning and evening), taking away clouds that give rain and brings some coldness.	
	Low temperatures persist in period when higher temperatures are expected.	August/ September
	Very scattered rains instead of heavy downpours than dry spell.	
Riverine	Rapid drying up of dams and the river	
Celestial	Sun with circles, easy to look at. Sun gets dim.	
	Moon with circles (but also no ring surrounding the moon), moon with very small halo.	
	A group of stars make a long line (*Nkhwasa*); stars shine more brightly at night	
	Sun at sunset appears to have coincided with the moon	
	Red horizons at sunrise and sunset	

4.3 Early action on floods and droughts based on indigenous early warning systems

Indigenous early warning signs documented and discussed in section 4.1 and 4.2 constitute a component of the overall indigenous early warning systems. In order to fully assess the functioning of the system, one must understand if and how the indigenous forecasting signs are disseminated and communicated, and if communities act on the information provided. As early actions for droughts and for floods show similarities, we will discuss them together in this section.

Across the case study communities, a number of coping and mitigation strategies were observed. Throughout generations, upon observing indigenous flood and drought forecasting indicators, community members have developed various mechanisms that assisted them in reducing impacts and taking early action. Communities mostly described actions taken at household level although also in some cases actions taken at community level. For the purpose of this report, actions have been classified into the following provisional categories, see Table XY.

Table XY Overview of categories of early action for floods and droughts

Category	**Floods**	**Droughts**
Livelihood modification	x	x
Food and fodder management	x	x
Livestock management/preparedness	x	x
Relocation and evacuation	x	
Preparation of houses and temporary shelters	x	
Water management		x
Ecological restoration/Green infrastructure		x
Other (religion, family life)		x

These early actions can also be classified according to the earlier three categories of impacts: human, economic and environmental and social impact.

Documenting and understanding actions undertaken by communities can serve as a valuable source of information for the stakeholders involved in community-based disaster risk reduction in Malawi. Integration and building on local practices in external actions (e.g. official early warning message) can lead to increased community resilience and to implementation of projects in a more cost-effective, sustainable manner. An another important aspect is understanding the timing of the actions, since this can instruct the external sources of official early warning information, thus creating warnings tailored towards location specific needs. However, documented early actions in this study demonstrated a high level of discrepancy and applicability between different communities; and methodologically, it proved to be a challenging task to attach timing to a specific action. Through the consultation with communities, it emerged that specific actions are undertaken not merely based on the indigenous forecasting signs, but through a complex interplay of this information with the official early warning communities received. In addition, it was apparent that actions were triggered by a combination of different indigenous indicators, as opposed to action being triggered by a sole indicator. An example of this combination was given by a female FGD participant in Mchacha:

'*When we see all of those signs we get to know that we are going to have more waters which will result in floods, because these signs cannot be ignored since that is what our forefathers used to tell us and that is what is happening. When we see all these (signs) we start preparing ourselves…*'

It was also very clear that deciding on early actions to take was usually a difficult and painful decision process. The female FGD in Gooke expressed that when they said: "How do you keep food while drought is at your door, children are dying and you keep food is that what you mean?".

Table XY gives an overview of the different early actions to address flood and droughts/dry spell impacts, their timing and action category.

Impact	Action	Timing	Early action to address flood impact	Early action to address drought/dry spell
Human impact	Food management	Months before the event.	**Food storage** : maize flour is stored into sacks to prevent it from getting moist. Depending on the availability, some will also store millet, sorghum and potatoes. However, food storage was rather an exception, as community members emphasized that due to poverty, they are very often unable to keep food supplies. Building a 'sanja' or 'nthandala' in homes, a raised platform used to store food and seeds, thus preventing them to be damaged. In some instances, respondents reported that the food is being stored in their 'second' homes in the uplands.	**Food storage: some communities store food e.g.** drying sweet potatoes for use later at the maize mill, maize or cassava and keeping pigeon peas, but also several communities mentioned not storing food. One GVH explained they used to store food in granaries and or in sacks in the house (treated with luckina leaves to avoid weevil bites or with ashes as insecticide) but not anymore. Possibly related to locusts that destroy these storages. Not selling food.
	Preparation of houses and temporary shelters	Months before the event.	**Strengthen houses:** the foundations are improved by adding an extra layer of mud around the houses or also on the walls (if mud-brick house). Roofs by thatching (i.e. adding extra layers of grass and tree branches) and covering the roof with the sheets of plastic, thus preventing the water leakage alongside making roofs more resistant to blowing of heavy winds. Building temporary raised shelters in flood prone areas: 'Chete' made out of locally available wood and grass.	
	Relocation and evacuation	Very shortly before the event.	**Relocate** to the uplands to stay with relatives, in the evacuation centres (e.g. schools), tents or temporary shelters, renting a house or going to second home. In most cases, women and children, together with the livestock will move to the uplands, whilst men might stay in the lowlands, monitoring the situation. Some individuals will look for a safe place in the mountains or on the top of ant hills.	
Economic and environmental impact	Livelihood adaptation	Before the event	Decide to plant earlier in the season, thus avoiding crops being affected by floods.	Conservation agriculture such as mulching, move planting season from October to November, use early maturing and drought tolerant crop varieties (instead of maize plant finger/brush/long millet, Irish potatoes, goal, sorghum or rice). Use rice fields for growing maize. Sow cucumbers.
	Livelihood preparedness	Months before the event.		Keep seeds for replanting, be ready to plant as soon as first rains come (including land preparation).
	Livelihood adaptation	Months before the event.	Change planting places; own farming land both in the lowlands (i.e. next to the river banks) and upland.	Go to marshes or islands (*makungu*) to find areas with residual moisture. Go from upper lands to areas near a
	Fodder management	Months before the event.	The storage of fodder, for cattle and other livestock, but conditioned by the availability.	Store elephant grass.
	Livestock preparedness	Shortly before event	Chicken and goats are kept in '*kraals*', raised platforms made out of local materials to protect them during floods. Bigger animals, such as cattle, might be relocated to graze in the uplands and no longer close to the river banks.	Take livestock to Thangadzi or Shire River for grazing.
	Ecological restoration/Green infrastructure	Months before the event.		Plant trees along river banks to keep water longer.
	Water management	Months before the event.	N/a	Dig up temporary shallow wells, for example in gardens to be used for watering crop during short dry spells and for example up to 8 meters deep.
	Water management	N/a	N/a	All communities mentioned not storing water anymore, although their parents used to do this with very big water
	Livelihood adaptation			Do piece/petty work before droughts arrive so that some money can be saved for buying food during the drought. Or move when the droughts arrive e.g. to wetland (*dambo*)
Social impact	Religion	Just before events		Chiefs go to mountains wearing black clothes to bring offerings to gods.
	Family planning	Months before the event.		Decide not to have more children to save food.

Livelihood adaptation

As previously described, farming presents a predominant livelihood activities in the case study area, and shifting of the planting practices emerged as one of mechanisms used to minimise the flooding impacts. One of the key flood vulnerability factors in the Lower Shire Valley is farming close to the river banks, due to increased exposure of crops to the flooding waters. Hence, some community members, opt to own farming land both in the lowlands (i.e. next to the river banks) and upland. The study found that based on the indigenous flood forecasting indicators, some farmers will change planting places (i.e. plant in the uplands) or decide to plant earlier in the season, thus avoiding crops being affected by floods.

Food and fodder management

Food storage also emerged as one of the strategies communities use to prepare for floods. Maize flour, as the main nutrition in the Lower Shire Valley, is stored into sacks to prevent it from getting moist. Depending on the availability, some will also store millet, sorghum and potatoes. However, food storage was rather an exception, as community members emphasized that due to poverty, they are very often unable to keep food supplies. Hence, the storage of fodder, for cattle and other livestock, is also conditioned by the availability. Another strategy directly tailored towards reducing impacts of flooding is building a '*sanja*' or '*nthandala*' in homes, a raised platform used to store food and seeds, thus preventing them to be damaged by floods and heavy rains. In some instances, respondents reported that the food is being stored in their 'second' homes in the uplands.

Livestock management

The influence of floods on livestock and smaller animals (e.g. goats, pigs and chicken) presents an additional challenge for communities, since replacement of animals is very often beyond individuals financial capacity. Hence, participants explained different mechanisms they have developed for minimising the losses. For instance, chicken and goats are kept in '*kraals*', raised platforms made out of local materials with the goal of ensuring safety during the flooding event. Upon noticing heavy rainfall and water levels increasing, bigger animals, such as cattle, might be relocated to graze in the uplands, and the community members will advise each other not to feed the cattle close to the river banks. The results indicate that actions related to livestock management are primarily undertaken closer to the flooding event, based on the riverine and meteorological flood forecasting indicators.

Relocation and evacuation

Even though it proved challenging to determine the level of adherence to the warning message provided through indigenous channels, study participants elaborated that once when the advice for relocating from the flood hot-spot areas (i.e. lowlands) is given, some people will move to the uplands. In the uplands, there are several options where people will be staying. It is either with relatives, in the evacuation centres (e.g. schools), tents or temporary shelters, or renting a house. In addition, some individuals might own houses both in the lowlands and in the uplands. Villagers explained that in most cases, women and children, together with the livestock will move to the uplands, whilst men might stay in the lowlands, monitoring the situation. Closer to the imminent flooding event, based upon meteorological and riverine indicators, some individuals will look for a safe place in the mountains or on the top of ant hills. It proved evident that despite the vast number of long-term indigenous indicators (e.g. ecological), and an advice to relocate uplands, people in the case study communities will opt to wait closer to the flooding event or even already when the flood waters are approaching before making decision to relocate.

Preparation of houses and temporary shelters

Demonstrating an understanding and self-awareness of living in the flood prone areas, case study communities emphasized several ways through which the houses are strengthened prior to the expected heavy rains, strong winds and floods. The foundations are improved by adding an extra layer of mud around the houses. Furthermore, roofs are strengthened by the process of thatching (i.e.

adding extra layers of grass and tree branches) and covering the roof with the sheets of plastic, thus preventing the water leakage alongside making roofs more resistant to blowing of heavy winds. Those living in the houses made of mud-bricks might also add additional layers of mud. In addition to houses strengthening, building of temporary shelters was documented in Nsanje. '*Chete*' is a local name for raised temporary shelter made out of locally available wood and grass. Chetes will be constructed in the flood prone areas, and during the rainy season, families will be residing in these temporary shelters.

Other actions
During the analysis of the available date, several early actions were noticed that did not fit the provisional categorisation proposed above. For instance, upon seeing the water levels rapidly increasing (i.e. riverine indicators), people living in the lowlands, close to the river banks will position a stick (e.g. straight tree branch or a reed) in the river banks or close to the bank and monitor the speed at which waters are increasing. Based on this observation, the decision on possible evacuation will be made. In other instances, participants mentioned that water levels are just observed, without using a stick. Religion + family planning

Water management

Ecological restoration /green infrastructure
In addition, examples of making gullies in the ground to divert the flood waters flow and building physical barriers by filling empty sacks with sand and placing them next to the river were documented.
Furthermore, in some villages, communities organise and strengthen the river banks, by planting trees and grass.

4.4 How reliable are indigenous EWS?

The idea underpinning any early warning systems for natural hazards is that it provides timely information of the hazardous events with the aim of reducing losses and damages (Sattele et al. 2015). In general, early warning systems can be considered reliable if the information on the upcoming event is generated, communicated and disseminated in time; and if the number of false or missed events is low. Scientific early warning systems are associated with a level of uncertainty, due to its' reliance on imperfect measurement data and future climate and weather forecasts. With this information in mind, the present study attempted to explore with the local communities how reliable do they find their indigenous early warning systems.

Across case study communities, opinions on the reliability of indigenous early warning indicators were differing, even though most of the study participants found IK indicators reliable and accurate. The cultural dimension of IK was emphasized. For instance, a participant from Mchacha pointed out

'W*ith our village life, they are reliable since our forefathers used them.*'

Even though IK signs for floods, dry spells, and droughts are generally considered to be reliable, the results show that very often, timely action to reduce the losses is missing, as well as effective communication and dissemination of the warning message. As a key informant from Kalima narrated:

'*When things do happen we then connect the dots on the signs observed*'. In some instances communities explained that the reliability of IK warnings signs has decreased due to changes in climate and environment, and due to prescribing the occurrence of natural hazards to '*God's will*' (female FGD, Khungubwe) causing perception that communities are not in position to forecast upcoming events. Furthermore, some communities demonstrated understanding of the inherent uncertainty of early warning systems, both indigenous and official. As explained by a key informant from Chapinga:

'*Sometimes they are reliable. It is just same as the messages we get from the radio. They might tell us it will rain in the Shire Valley but rains do not come. These (IK signs) are just part of our belief but they may or may not happen.*'.

In addition, participants noted that younger generations demonstrate less reliability towards the IK signs. A female respondent from Gooke said:

'The children of today despise us elderly people when we tell them to be alert based on on these signs and they say: have you ever gone to heaven and see what is about to happen on Earth? After that they ignore us and as a result we just keep them to ourselves'.

4.5 Systems for message sharing

Systems of message sharing constitute a crucial aspect of the overall indigenous flood forecasting communities, since they provide an understanding of how the observed information is disseminated to different community members and groups.

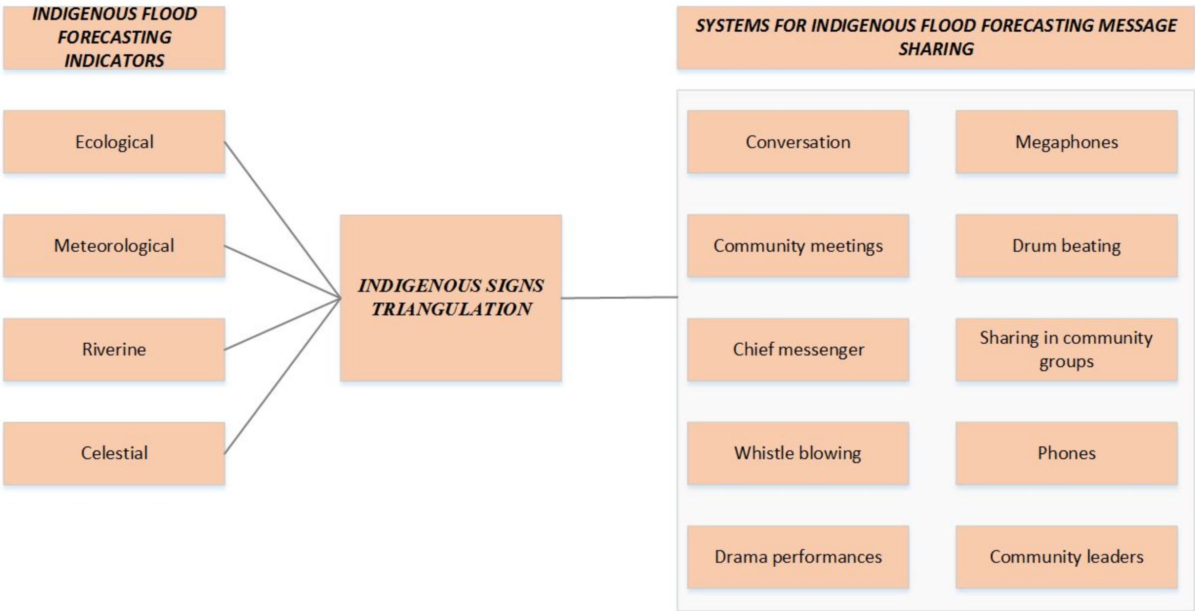


Figure XY: System for indigenous flood forecasting message sharing[10]

[10] As already elaborated, action taken by communities is a result of triangulation between various indigenous early warning signs and official warning information. For the purpose of this Figure, only indigenous flood forecasting indicators are included.

As presented in in Figure XY, upon observing and triangulating different indigenous flood forecasting indicators communities use a vast array of means for communicating and disseminating the message. Indigenous signs are observed by community members, and shared informally through conversation in households between family members, and with neighbors. As narrated by a female from Bande:

'*Most of the times we ask our neighboring homes if they are also seeing these signs. For example, we might ask one another if the ants are occuring on their houses and if they say yes, we remind each other that floods are coming so we should be ready*.'

The role of traditional leaders in disseminating the warning messages was repeatedly emphasized. For instance, chiefs will call their community members for meetings, where the signs and their implications for the upcoming season will be discussed. An another example is chief sending a messenger to disseminate the message through a village. A female FGD participant described:

'*Chiefs tell their people that according to the observation of nkhululu (bird) coming out, we need to be alert that anytime we can have floods, and we should try by the time the rains have approached people from lower placer should shift to upper places so we can be safe*'.

Community meetings are also organised by the members of the local VCPC (Village Civil Protection Committee). Observed indigenous flood indicators are also shared during meeting of various village level groups (e.g. farmers or women), during religious ceremonies, and drama performances. It was noted that during these various types of meetings the main message conveyed was tailored towards individuals living and farming close to the river banks, in the lowlands. These community members are advised to relocate to the uplands, thus avoiding more severe consequences of the upcoming flood. Depending on a community, meetings will start being conducted already prior to the flooding season.

Whilst community meetings serve the role for raising awareness of possible flooding in the rainy season, various mechanisms for disseminating the warning message prior to the imminent flood were documented. Members of the VCPC, chief messengers and other community members will blow whistles, use megaphones, phones, run and shout through the village and warn people to evacuate from the flood prone zones. Across case study communities, drums are also used to disseminate the warning information. An interviewee from Gugumiya explained:

'*We also beat drums as a mean of communicating messages about impending flooding. The beating of a drum follows a specific pattern using a specific type of drum and people know that this type of drum beating means that someone is communicating a message and they pay attention and listen to the message*'.

4.6 Access to and reliability of the official early warning information

Even though the scope of the present study is highly tailored towards exploring the indigenous hazard forecasting systems, throughout the data collection and analysis, the high level of intertwined nature between indigenous and official warning information proved evident. Hence, this section will explain more closely the type of official warnings regarding floods and dry spells received by the communities in the case study region. The official flood warning system in the Lower Shire Valley dates back to 1956, when a manual system was installed, and it was automatized in 1991. However, due to lack of real time data, inappropriate operation and maintenance, this system is not of high efficiency (Shela, 2008). There was no available data on the history of drought and dry spell early warning system in Malawi. A more detailed explanation of the existing official EWS in Malawi was provided in the Introduction.

The main source of official warning information across the case study communities are seasonal weather forecasts produced with a spatial resolution of the district by the Department of Meteorological Services and Climate Change and issued prior to the start of the rainy season (i.e. September/ October). The information on possible flooding is conveyed to communities primarily through radios, by advising those living in the flood prone areas (i.e. lowlands) to move to the uplands. However, due to a high levels of poverty, radios are not accessible to all community members, and individuals without access to radios will receive information from fellow villagers and members of the Village Civil Protection Committee. A female FGD participant from Mchache explained:

'*We have already said that those who have radios and do manage to buy batteries, they do get the information for us that do not have radios or cell phones, so we are just waiting to hear from the VCPC members*.'

Messages about the upcoming flooding are also conveyed through NGOs and governmental departments working in the communities, and through cell phones (e.g. VCPC members have been equipped with cell phones). For instance, vehicles disseminating messages will be moving through villages and NGOs will use drama performances to raise awareness. Some study participants also pointed out that the message about the upcoming flood is received from the upland communities.

Venues for receiving early warning information on droughts and dry spells tended to be similar to those for flooding. However, it was noticed that the access to the information on these slow-onset hazards is less than to flood information. Communities indicated that even in the case when seasonal forecasts are communicated (e.g. by forecasting below normal or late onset rains), the message is not explicit, and community members conclude themselves a dry spell or drought is coming. Messages from the radios come in the form of advice on adjusting the farming practices by recommending earlier planting and usage of hybrid, early maturing seeds.

Similar to the reliability of the indigenous warning information, communities expressed a varying degrees and perceptions of official warning reliability. Numerous examples of low reliability and adherence to the official message were given. A male FGD participant from Nyan'ga, when asked if they trust the official warnings, narrated :'*Not really because most of the things they say do not happen*'. Participants pointed out that sometimes, opposite happens of what has been forecasted:

'*Yes (we trust them) but sometimes we do not. For example, they tell us that there will be floods and then not even enough rainfall comes that year.*' (male, FGD Kamanga)

However, in some instances, communities explained that in the past, losses and damages were suffered due to the lack of adherence to the official warnings:

‘*...most of the things they say do not happen, but because of 2015, we take note of what they tell is. In that year, when we were warned, we did not believe them but the end result was that we lost most of our relatives. So from then, we take heed when these officials warn us*.’ (male, FGD Gooke)

Results of this study indicate that the official early warning system is in a need for improvement, in terms of the spatial and temporal resolution. Furthermore, means and contents of the warning messages in the existing system do not clearly convey to communities affected by hazards.

5 Discussion

By taking a qualitative and inductive strand, the present study explored the availability of indigenous early warning systems for the most common hydro-meteorological hazards in the Lower Shire Valley. By engaging with 17 different communities, the findings indicate a number of IK indicators used by local people for forecasting the upcoming hazards of floods, droughts and dry-spells. The indicators that emerged through a conversation with study participants can be clustered under four different categories: ecological, meteorological, riverine and celestial indicators. It is apparent that a vast majority of indicators are directly related with people observing and noticing changes in their natural surroundings, and are highly contextualised and case-specific. However, due to a similar geographical, social, cultural and economic contexts of communities studied, indicators between the communities demonstrate a high degree of resemblance. This serves as a valuable lesson for the external parties (e.g. NGOs and governmental departments) working with communities in the Lower Shire Valley. However, there is a need to fully recognise that efforts should be taken into understanding a level to which this community and context specific knowledge system can be ‘packaged’ and ‘upscaled’ beyond its area of production and use. Nevertheless, there is not doubt that taking into discussion local perspectives on EWS should be a starting point if a people-centred EWS, as one of the Disaster Risk Management Policy priority areas in Malawi, are to be established.

It was evident from the present study that communities in the Lower Shire Valley develop and employ a range of coping and mitigation strategies (in this study coined as ‘early action’) to minimise the effects of most common hazards on their lives and livelihoods. This research provided a detailed account of actions, as presented in the Results section. However, it was also evident that despite a large number of actions, these are not equally employed by community at large, and often, the IK warning indicators are not accounted for, thus leaving communities impacted by hazardous events. Possible explanations are inadequate dissemination and communication, lack of timely action and perceived decrease in the reliability of IK warnings indicators. Furthermore, as findings of this study indicate, any early action at local levels is not informed solely by a single knowledge system, in this case indigenous knowledge system. Communities under consideration reported that they do receive some official warning information on the impending hazards (e.g. through radions, phones or NGOs visiting the area). Hence, based on the complex process of triangulation between different sources of warning information, a decision to take early action is taken. This indicates that, as any other knowledge system, the IK for EWS is constantly evolving and adapting to changing circumstances. In any case, fully understanding the local ways of coping and mitigating, accounting for them and integrating them into planned interventions could improve the existing approaches taken by NGOs and government, and create more cost-effective interventions to DRR and humanitarian interventions in the region.

To a certain degree, official warning information has been available to all communities consulted in this research, especially for floods, while provision of information on droughts and dry-spells still remains a challenge. The challenges with the available warning information is that it is not delivered to end-users in a timely and accurate manner, resulting in the perceived low reliability of the official warning information. The existing dissemination and communication channels, coupled with a relatively low spatial resolution of forecasting (i.e. district level) leave a room for improvement in the official EWS. Furthermore, as this study and findings from the literature inform, there is a need to develop effective ways to integrate indigenous and official warning systems. This process is ought to be further researched, piloted and tested, and needs to be done in a close cooperation with local communities.

Lower Shire Valley findings on the perceived decreasing reliability of IK warnings signs are in line with the previous research. For instance, Kagunyu et al. (2016), while exploring the use of indigenous climate forecasting methods by the pastoralists of Northern Kenya found that increasing frequency and severity of droughts over the last decade has influenced the reliability of indigenous forecasting in a negative manner. Findings of this have to be looked also through a lens of methodological choices. The sampling for this study was tailored towards elderly people in the communities, under the assumption of these individuals being most knowledgeable about the topic, and accustomed to using these signs. It was however apparent that communities experience the effects of changes and processes of globalisation on their indigenous knowledge systems, and that these systems are under the increased threat. Despite uncertainty surrounding the reliability of IK for EWS, the results of this study give a feel that in general, indigenous EWS is perceived to be generally more reliable than the official warning information. This may be due to previously discussed gaps in the existing official system. However, to reach a definite conclusion on this matter, the authors of this report recommend a follow-up study that would explore and compare reliability of different early warning systems in Malawi. Previous studies have shown, that in the absence of official warning message, communities predominantly rely on indigenous knowledge (e.g. Cumiskey, 2013).

There are several limitations of the present study. Firstly, the data collection process in each of the communities was rather short, with a half-day visit by a research team. However, due to a long-standing relationship between the MRCS and communities studied, there was an existing rapport and research team members were able to elicit as much information as possible. Secondly, even though the composition of the FGD participants was communicated to community leaders in advance, sometimes the FGDs consisted of more than two individuals below the age of 55. However, as experienced through the analysis process, this has provided a an opportunity to explore the notion of IK for DRR from a perspective of not only elderly community members (as usually done in IK studies) but rather from community at large, thus creating a more realistic image. Thirdly, it proved challenging to attach a specific timeline to observed indicators and identify a trigger level for a certain indicator (e.g. understanding the severity of upcoming floods and heavy rains based on the number of ants occuring in the area). One possible solutions for this could be using some of the more participatory tools from the PRA spectrum. Furthermore, in many instances, it was not possible to take a photographic evidence of commonly mentioned forecasting indicators, due to a location far away from where interviews and FGDs were taking place and a timing of the study. Also, as communities were giving examples of indicators in local language (e.g. specific tree or animal species), it was not always possible to get an english or scientific name of the species. Hence, there is a need to engage a larger team, composed of experts from different fields (e.g. botany, zoology) that would, by closely working with communities, be able to extract the exact information. Finally, since the FGDs and KII were conducted in local language, some information has been lost in translation to English. Every effort was made to minmise this effect on validity of findings.

Difference indicators drought and floods?
Similarities/paralles?

Link impact and early actions. How can this feed into SOPs for FbF/Early Warning-Early Action?

Literature on reliance on scientific vs indigenous EWS? See MSc thesis Lydia?

6 Conclusions and recommendations

Implications for the core DRR stakeholders in Malawi

How to strenghten the use of IK in CB-EWS and national EWS?

Actors and their role in the flood and/or drought EWS can be mapped on the EWS components (Risk knowledge, Monitoring and Warning, Dissemination and Communication, Response Capability) at both national, local and transboundary level. The Figure XY is only a very first mapping; a more comprehensive mapping of the current or potential Early Warning/Early Action actors will be done as part of the *EU ECHO Preparedness for response and Early Action in Malawi* proposal. For each actor, it should be assessed if and if so, how this actor could integrated indigenous knowledge into its operations. Subsequently, as part of the multi-hazard early warning strategy that will be developed, it should become clear what the means of implementation, i.e. technology, finance and capacity are for these actors as well as the mandates and policies that govern these.

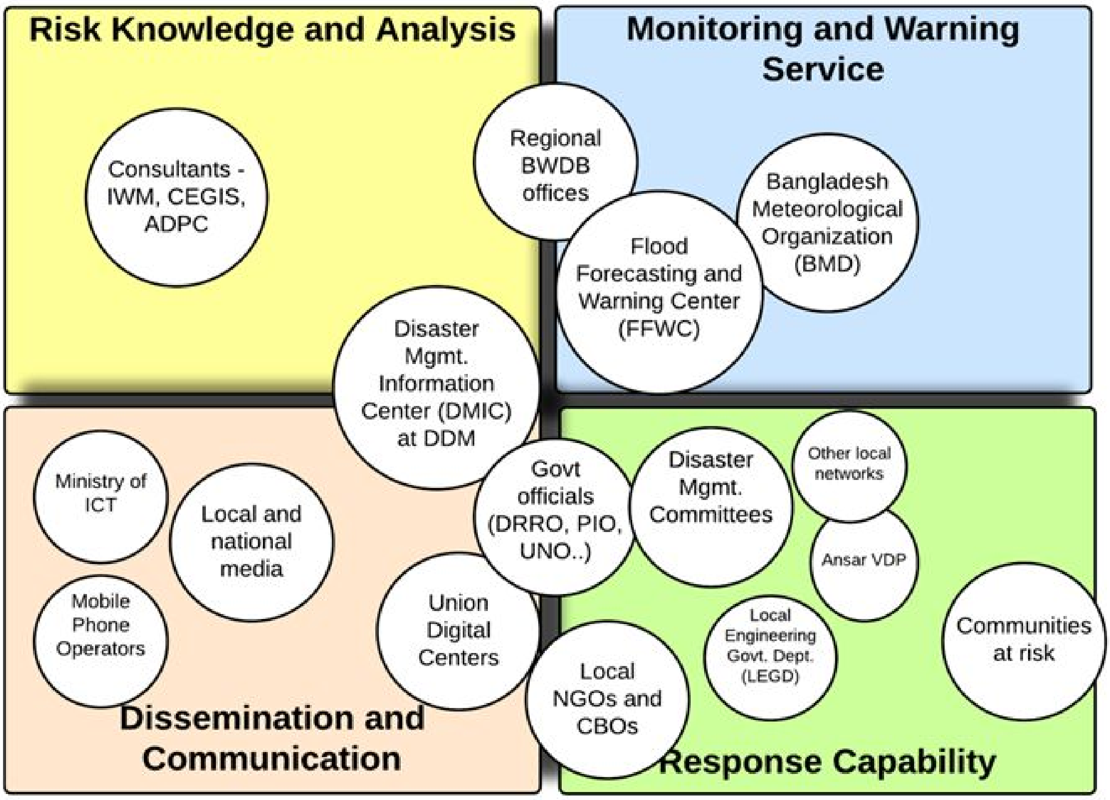
In addition, it will be useful to align with similar efforts in neighbouring countries such as Zambia (where UNDP has initiated a study on indigenous knowledge) and Mozambique.

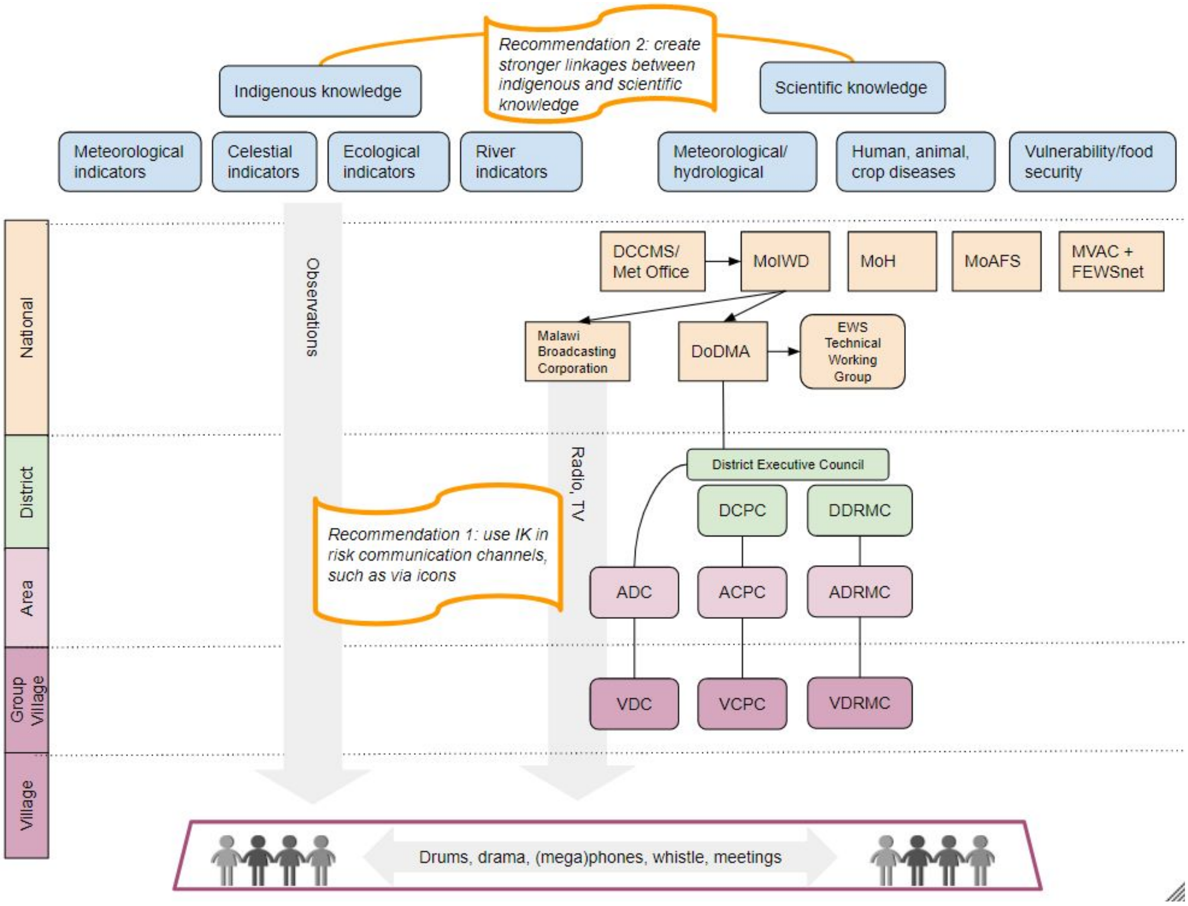
Link impact and early actions. How can these findings feed into SOPs for FbF/Early Warning-Early Action? Will be tried in Ikea Foundation project.
Setup crowdsourcing to make IK indicators reach official channels?

Create and use icons that represent indigenous early warning indicators so that these can be used to communicate scientific early warning system messages to communities.

Instead of focus group discussion use a game like Memory Strings

In the Uganda and Togo pilots, the project teams examined the historical record of disasters, including local memories of events and recorded documents and impact databases. An interactive game called "Memory Strings" was designed to encourage discussion of historical events (see Appendix A), and rolled out in project areas to capture historical timelines. The team also compiled available disaster datasets from the Red Cross National Society and online records such as Desinventar and the IFRC DREF database. It is critical to consult many information sources to gather a timeline of past events, as perceptions of impact can vary. Based on this initial pilot, it was clear that people living in one location can agree on the dates of the largest historical disasters, but differ substantially in their recollection of smaller disasters. We recommend consulting the local population about what events they can remember, but also asking them to provide more information about the events that are documented in databases or newspapers to validate and verify those sources. (see http://www.climatecentre.org/downloads/files/Stephens%20et%20al.%20Forecast-based%20Action%20SHEAR%20Final%20Report.pdf)





Link to ECHO 3 multi-hazard EWS

Although there are many ways to incorporate user information into forecasting systems, this study showed that an iterative self-improving forecast system should be developed. This system will involve changing the decision-making information throughout a flood season, changing thresholds for flood-inducing rainfall depending on prior weather and hydrological conditions and dynamic user-oriented assessments of the skill and uncertainty of a prediction. Conceptual study on incorporating user information into forecasting systems. Available from: https://www.researchgate.net/publication/241038018_Conceptual_study_on_incorporating_user_information_into_forecasting_systems [accessed Apr 30 2018].

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8 APPENDIX 1- Focus Group Discussion and Key Informant Interview Guides

Flooding

OVERVIEW OF THE FLOODING SITUATION IN THE COMMUNITY

1. How often floods occur in your community?
    a. In which periods of the year (months)?
    b. Can you recall major flooding events in your community during your lifetime? What year, in which month?

2. What are the main impacts floods have on your community?

INDIGENOUS EARLY WARNING FOR FLOODING

Part 1 BEFORE THE FLOOD (FEW MONTHS TO A WEEK BEFORE THE FLOODING EVENT)

Part 1a INDIGENOUS EARLY WARNING INDICATORS

1. How do you know there will be flooding in your community in the rainy season? What are the indigenous early warning signs that help you to know that the flood is coming?
    a. Animal behaviour
        i. Which animal?
        ii. How do the animals behave?
        iii. In which period animals behave this way (months)?
    b. Plants (e.g. trees, flowers, riverine flora)
        i. Which plants?
        ii. What is the behaviour of plants (e.g. lot of flowers)?
        iii. In which period is this occuring (months)?
    c. Celestial bodies (moon, stars, sun)
        i. What is the behaviour of the celestial bodies?
        ii. In which period (months) this occurs?
    d. Meteorological (temperature, winds, rainfall, clounds)
        i. Rainfall patterns, rainfall intensity?
        ii. Do winds blow the specific way and from specific directions?
        iii. Is it getting too hot, or the temperatures are the same?
        iv. Any specific cloud movements or shapes?
        v. In which periods (months) the above mentioned occur?
    e. Any additional indicators? Such as from spiritual leaders?

Part 1b ACTIONS TAKEN AND SYSTEMS FOR MESSAGE SHARING

1. Is there any action you will take to prepare for the flooding based on the indigenous early warning signs you explained us earlier? What type of action?
    a. Livelihood modification (e.g. shifting of planting season, change of planting place, change of crops planted)
        i. In what period is this being done?
        ii. How long before the flood?
        iii. Elaborate on all the actions
    b. Food and fodder (e.g. food storing)
        i. Do you store any food based on the indigenous early warning signs?
        ii. If yes, where do you store the food? What kind of food?

iii. In what period is this being done?
iv. How long before the flood?

c. Livestock (e.g. preparation and relocation of livestock)
   i. Will you move your livestock (poultry, cattle, goats, pigs)?
   ii. If yes, where?
   iii. In what period (months) is this being done?
   iv. How long before the flood?
d. Temporary shelters construction
   i. Will you construct any temporary shelter based on the indigenous early warning signs you have observed?
   ii. If yes, when is this being done (how long before the flood) and in which period (month)?
   iii. Where will the shelters be constructed?
e. Relocation uplands
   i. Are you going to move uplands based on the indigenous early warning sign you have observed?
   ii. If yes, how long before the flood and in which month?
   iii. If yes, where will you move?
f. Preparation of the houses
   i. Based on the indigenous early warning signs, are you going to prepare your house to withstand the effects of flooding?
   ii. If yes, what type of preparation?
   iii. How long before the flood will this be done and in what period (month)?
g. Any other action?

2. Do you share the indigenous early warning signs with the others in your community? (We note this is a different form of sharing than immediately before the floods).
   a. Family members?
   b. Chiefs?
   c. Other community members?
   d. How do you share this message?
      i. Conversations (e.g with family members in the household)?
      ii. Mobile phone
      iii. Songs?
   e. When you you share the message (e.g. immediately after you observe the signs or later)?
   f. How frequently will you share the message?
3. Are there any meetings in your village through which the message is shared?
   a. Example: village meetings, during religious ceremonies, VCPC meetings
   b. Who will organise and call for these meetings?
   c. How often are these meetings being done in the rainy season?
   d. When will these meetings be organised (months)?
4. Do you share the indigenous early warning indicators with the NGOs working in your area or with government staff (e.g extension workers)?
5. Can you tell based on the indigenous early warning signs how severe the flooding will be?

a. A pointer for the facilitators: In this questions, prompt the communities by asking if based on for example, a number of ants, they can say how severe the flooding event will be?

Part 2 IMMEDIATELY BEFORE THE FLOOD (A WEEK BEFORE THE FLOODING EVENT TO THE ACTUAL FLOODING EVENT)

Part 2a INDIGENOUS EARLY WARNING INDICATORS

1. What are the indigenous early warning signs that help you to know that the flood is coming?
   a. Animal behaviour
      i. Which animal?
      ii. How do the animals behave?
      iii. How long (days) before the floods occur this happens?
   b. Plants (e.g. trees, flowers, riverine flora)
      iv. Which plants?
      v. What is the behaviour of plants (e.g. lot of flowers)?
      vi. How long (days) before the flood occur this happens?
   c. Celestial bodies (moon, starts, sun)
      vii. What is the behaviour of the celestial bodies?
      viii. How long (days) before the floods this happens?
   d. Meteorological (temperature, winds, rainfall, clounds)
      ix. Rainfall patterns, rainfall intensity?
      x. Do winds blow the specific way and from specific directions?
      xi. Is it getting too hot, or the temperatures are the same?
      xii. Any specific cloud movements or shapes?
      xiii. How long (days) before the flood happens this occurs?
   e. River behaviour
      xiv. Colour of the river waters?
      xv. Velocity of the river waters?
      xvi. Sound water is making?
      xvii. The rate at which water levels are increasing?
      xviii. How long (days, hours) before the flood these changes are occuring?
   f. Any additional indicators? Such as from spiritual leaders?

Part 1b ACTIONS TAKEN AND SYSTEMS FOR MESSAGE SHARING

1. Is there any action you will take to prepare for the flooding based on the indigenous early warning signs you explained us earlier? What type of action?
   a. Food (e.g. food storing)
      i. Do you store any food based on the indigenous early warning signs?
      ii. If yes, where do you store the food? What kind of food?
      iii. How long before (days, hours) the flood?
   b. Livestock (e.g. preparation and relocation of livestock)
      i. Will you move your livestock (poultry, cattle, goats, pigs)?

ii. If yes, where?
iii. How long (days, hours) before the flood?

c. Relocation uplands
    i. Are you going to move uplands based on the indigenous early warning sign you have observed?
    ii. If yes, how long before the flood come?
    iii. If yes, where will you move?
d. Evacuation
    i. How will you make a decision to evacuate?
    ii. How long before the flood (days, hours) will you evacuate?
    iii. What will you use to evacuate (e.g. walking, oxcart, canu)
    iv. Where will you evacuate?
e. Will you monitor the water levels in the river?
    i. How will you monitor the water levels (e.g. by using the reed or a tree branch)?
    ii. How frequently will you monitor the water levels?
    iii. How do you determine what water level tells you it is time to evacuate?
f. Any other action?

2. How do you share the early warning message based on the indigenous signs prior to the flooding?
    a. What media are you using the share the message (e.g. drums)?
    b. If drums are mentioned, what is the sound that is sent? How far can it travel?
    c. How frequently will you share the message in this period?
    d. How long (days, hours) before the flood you share the message?

3. Are there any meeting in your village immediately before the floods through which the message is shared?
    a. Example: village meetings, during religious ceremonies, VCPC meetings
    b. Who will organise and call for these meetings?
    c. When will these meetings be organised (days or hours before the flood)?

4. Can you tell based on the indigenous early warning signs immediately before the floods how severe the flooding will be?
    a. A pointer for the facilitators: In this questions, prompt the communities by asking if based on for example, the rate of the increase in the water levels, they can say how severe the flooding event will be?

Drought and dry spell

OVERVIEW OF THE DROUGHT AND DRY SPELL SITUATION IN THE COMMUNITY

1. How often droughts occur in your community?
    a. In which periods of the year (months)?
    b. Can you recall major droughts in your community during your lifetime? What year, in which month?

2. What are the main impacts droughts have on your community?
3. How often dry spells occur in your community?

    a. In which periods of the year (months, rainy season and outside of the rainy season?)
4. What are the main impacts dry spells have on your community?
5. How do you differentiate between:
    a. Dry spells and normal season
    b. Dry spells and extended dry spells?
    c. Extended dry spells and a drought?

INDIGENOUS EARLY WARNING FOR DROUGHTS

Part 1 INDIGENOUS EARLY WARNING INDICATORS

1. What are the indigenous early warning signs that will tell you that the drought period is coming?
    a. Animal behaviour
        i. Which animal?
        ii. How do the animals behave?
        iii. In which period animals behave this way (months)?
    b. Plants (e.g. trees, flowers,)
        i. Which plants?
        ii. What is the behaviour of plants (e.g. lot of flowers)?
        iii. In which period is this occuring (months)?
    c. Celestial bodies (moon, starts, sun)
        i. What is the behaviour of the celestial bodies?
        ii. In which period (months) this occurs?
    d. Meteorological (temperature, winds, rainfall, clounds)
        i. Rainfall patterns, rainfall intensity?
        ii. Do winds blow the specific way and from specific directions?
        iii. Is it getting too hot, or the temperatures are the same?
        iv. Any specific cloud movements or shapes?
        v. In which periods (months) the above mentioned occur?
    e. Any additional indicators?

Part 2 ACTIONS TAKEN AND SYSTEMS FOR MESSAGE SHARING

1. Is there any action you will take to prepare for the droughts based on the indigenous early warning signs you explained us earlier? What type of action?
    a. Livelihood modification
        i. Are you going to change your planting practice (e.g. crops you plant, periods in which you plant? Elaborate
        ii. When will this happen (period- month before the droughts)
    b. Food storing
        iii. Do you store any food based on the indigenous early warning signs?
        iv. If yes, which period (month) before the droughts you are going to store this food?
        v. What type of food do you store?
    c. Storing water for use (e.g domestic use, use for farming and cattle)

vi. Do you store any water for different uses?
vii. If yes, when (month and period before the drought) and how?
d. Any other action?

2. Do you share the indigenous early warning signs with the others in your community?
   a. Family members?
   b. Chiefs?
   c. Other community members?
   d. How do you share this message?
      viii. Conversations (e.g with family members in the household)?
   e. When you you share the message (e.g. immediately after you observe the signs or later)?
   f. How frequently will you share the message?
3. Are there any meeting in your village through which the message is shared?
   a. Example: village meetings, during religious ceremonies, VCPC meetings
   b. Who will organise and call for these meetings?
   c. How often are these meetings being done in the rainy season?
   d. When will these meetings be organised (months)?
4. Do you share the indigenous early warning indicators with the NGOs working in your area or with government staff (e.g extension workers)?
5. Can you tell based on the indigenous early warning signs how severe the drought will be?
   a. A pointer for the facilitators: In this questions, prompt the communities by asking if based on for example, a flowering of mangoes, they can say how severe the flooding event will be?

INDIGENOUS EARLY WARNING FOR DRY SPELLS

Part 1 INDIGENOUS EARLY WARNING INDICATORS

1. What are the indigenous early warning signs that will tell you that the dry spell is coming?
   a. Animal behaviour
      i. Which animal?
      ii. How do the animals behave?
      iii. In which period animals behave this way (weeks, days)?
   b. Plants (e.g. trees, flowers,)
      i. Which plants?
      ii. What is the behaviour of plants (e.g. lot of flowers)?
      iii. In which period is this occuring (months)?
   c. Celestial bodies (moon, starts, sun)
      i. What is the behaviour of the celestial bodies?
      ii. In which period (months) this occurs?
   d. Meteorological (temperature, winds, rainfall, clounds)
      i. Rainfall patterns, rainfall intensity?
      ii. Do winds blow the specific way and from specific directions?
      iii. Is it getting too hot, or the temperatures are the same?
      iv.Any specific cloud movements or shapes?
      v. In which periods (months) the above mentioned occur?

e. Any additional indicators?

Part 2 ACTIONS TAKEN AND SYSTEMS FOR MESSAGE SHARING

1. Is there any action you will take to prepare for the dry spells based on the indigenous early warning signs you explained us earlier? What type of action?
   a. Livelihood modification
      i. Are you going to change your planting practice (e.g. crops you plant, periods in which you plant? Elaborate
      ii. Do you have any indigenous practice that will help you to protect your crops against a dry spell?
      iii. When will this happen (period- month before the dry spell)
   b. Food storing
      i. Do you store any food based on the indigenous early warning signs?
      ii. If yes, which period (month) before the droughts you are going to store this food?
      iii. What type of food do you store?
   c. Storing water for use (e.g domestic use, use for farming and cattle)
      i. Do you store any water for different uses?
      ii. If yes, when (month and period before the dry spell) and how?
   d. Any other action?

2. Do you share the indigenous early warning signs for dry spells with the others in your community?
   a. Family members?
   b. Chiefs?
   c. Other community members?
   d. How do you share this message?
      ix. Conversations (e.g with family members in the household)?
   e. When you you share the message (e.g. immediatelly after you observe the signs or later)?
   f. How frequently will you share the message?
3. Are there any meeting in your village through which the message is shared?
   a. Example: village meetings, during religious ceremonies, VCPC meetings
   b. Who will organise and call for these meetings?
   c. How often are these meetings being done in the rainy season?
   d. When will these meetings be organised (months)?
4. Do you share the indigenous early warning indicators with the NGOs working in your area or with government starr (e.g extension workers)?
5. Can you tell based on the indigenous early warning signs how severe the dry spell will be?
   a. A pointer for the facilitators: In this questions, prompt the communities by asking if based on for example, a flowering of mangoes, they can say how severe the flooding event will be?

Reliability of Indigenous Early Warning and Accessibility to official early warning information

RELIABILITY OF INDIGENOUS EARLY WARNING

1. Are the indigenous early warning signs for floods reliable and accurate?

    a. Elaborate
    b. Ask for examples: for instance, if communities say NO, ask them for an example when it was not reliable
    c. If YES, ask them to explain more why do they find it reliable
2. Are the indigenous early warning signs for droughts reliable and accurate?
    a. Elaborate
    b. Ask for examples: for instance, if communities say NO, ask them for an example when it was not reliable
    c. If YES, ask them to explain more why do they find it reliable
3. Are the indigenous early warning signs for dry spells reliable and accurate?
    a. Elaborate
    b. Ask for examples: for instance, if communities say NO, ask them for an example when it was not reliable
    c. If YES, ask them to explain more why do they find it re

ACCESSIBILITY TO OFFICIAL EARLY WARNING INFORMATION

1. Do you get any official information about the rainfall (e.g. seasonal forecasts)?
    a. Who gives you this information?
    b. When do you get this information (months)?
    c. What is the content of the information given?
    d. How frequently is this information given to you?
    e. How do you hear about this information (example: radio, other villagers, chiefs, NGOs, government workers)?
2. Do you get any official warning information about flooding in the rainy season?
    a. Who gives you this information?
    b. How long before the flooding comes you get this information?
    c. How frequent is the warning information?
    d. What is the content of the message given to you?
    e. How do you hear about this information (example: radio, VCPC members, chiefs, NGOs, government workers)?
3. Do you get any offical information about drought and dry spells?
    a. Who gives you this information?
    b. When is the information given to you?
    c. How frequent is the warning information?
    d. What is the content of the message?
    e. How do you hear about this information (e.g. radio, VCPC members, chiefs, NGOs, government workers)
4. Do you find official warnings you get for floods, droughts and dry spells reliable and accurate?
    a. Elaborate

9 APPENDIX 2- Indigenous early warning signs for flooding

Ecological indigenous early warning signs for flooding
ANIMALS

English name	Chichewa Name	Scientific Name	Behaviour	Period Observed
Ants	Nyerere, Nthendza, Agang'a	Formicidae	Increased number in houses and outside, affecting sleep. Ants are also seen collecting and storing food. Both small and bigger ants observed.	August to January
Phyton	Nsato	Phyton	It stays in a tree, when head pointing downwards means that more rain is coming. In some places, phytons change habitats and come from the rivers to villages.	October to January
Hippopotamus	Mvuu	Hippopotamidae	Moves away from the river and walks to the dry land. Floods will follow where the hippo goes, and it will not flood beyond the point hippo reached.	October to December

Tortoise	Khachi	Testudinidae	Normally not seen, but can be seen near the rivers in the times of flooding.	December to January
Frogs	Thesi, Nthesi, Chule	Anura	Produce a lot of sound. Immediately before the flood they move around.	September to January
Millipede	Dzongololo/ Bongololo	Diplopoda	Increased numbers in the villages; produce noise	October to December
Birds	1. Ng'ombe Ng'ombe 2. Anazeze 3. Mbalambe 4. Nazeze 5. Akakowa 6. Godomola 7. Mbaichuche 8. Songwe	1. Bycanistes bucinator 2. Not known 3. Not known 4. Not known 5. Ciconiidae 6. Not known 7. Not known 8. Not known	1. Produce a lot of sounds 2. Increase number and they fly around 3. Makes sounds and then stops immediately before the rains 4. Increased numbers and fly around more than usual 5. Increased numbers next to the river shores and sounds 6. The sound of the bird 7. The sound of the bird before the rains 8. The bird has a nest on tall trees and it rests on the nest and faces where the flood is coming	1. July to December 2. August to November 3. December 4. August to November 5. July to January 6. August to October 7. From December 8. From December
Cattle	Ng'ombe		The cattle act excited, chasing each other with raised tails. Animals are at unrest	October to December
Ducks	Bakha	Bucephala albeola	Ducks show signs of wanting to be in the waters, such as raising their wings.	October to December

Mosquitoes	Udzudzu	Culicidae	Increased number in the villages	August to December
Fish	Somba		Fisherman observe a lot of fish and catch more fish that usual.	December to January
Grasshopers	Tsokonombwe	Schistocerca	Make a lot of noise, especially during the night. It is often seen hopping all over the bushes.	October to January
Porcupine	Chisoni	Hystricidae	Seen around the village	September to November
Crickets	Nkhululu	Gryllidae	Increased number in villages	September to October
Rats	Mbewa	Muroidea	Increased occurrence in the villages, serve as food. They change habitats from river to villages.	September to December
Hare	Not known	Lepus	Coming out of the woods into the villages when it rains a lot.	Not specified
Antelope	Not known	Bovidae	Coming out of the woods into the villages when it rains a lot.	Not specified
Not known	Nkhaka	Not known	Found in the bushes	July to October
Spiders	Not known	Araneae	Coming out of the ground	From October
Mopane	Nthowa/ Nthchika	Gonimbrasia belina	Found in trees all over the area and people eat it.	From December
Cat			Cats always coming from west to east, means heavy rains are near	December-January
Snake			Along the Shire River, big snakes pass in the maize gardens and leaves a mark	November

Bed bugs			Bed bugs in large numbers	From September

PLANTS

ENGLISH NAME	CHICHEWA NAME	SCIENTIFIC NAME	BEHAVIOUR	PERIOD OBSERVED

Trees	1. Mkhunku 2. Janga 3. Mbwemba 4. Yembe/ Mtondo 5. Magwafa 6. Nkuyu 7. Kina/ Nimu 8. Nkolobwe 9. Mkotamo 10. Nyenja 11. Phakasa 12. Ntondo 13. Minyenja 14. Kunkhulu 15. Nyenza 16. Mkunkhu 17. Maswu 18. Chinese dates tree (local name not known) 19. Indian plums (local name not known) 20. Chilusa 21. Msolo 22. Nyika	1. Acacia Nigrescens 2. Not known 3. Adansonia 4. Cordyla Africana 5. Psidium guajava 6. Ficus 7. Azadirachta indica 8. Not known 9. Combretum obovatum 10. Not known 11. Not known 12. Not known 13. Not known 14. Not known 15. Not known 16. Not known 17. Ziziphus mauritiana 18. Ziziphus jujube 19. Oemleria cerasiformis 20. Lannea scweinfurthii 21. Pseudolachnostylis maprouneifolia 22. Nymphaeaceae	1. Increased flowering 2. Increased flowering 3. Increased production of fruits 4. Increased production of fruits 5. Increased production of fruits 6. Increased flowering 7. Increased flowering 8. Increased number of fruits 9. Increased flowering 10. Increased number of fruits 11. Increased number of fruits 12. Increased number of fruits 13. Increased number of fruits 14. Increased flowering 15. Increased number of fruits 16. Increased flowering 17. Increased flowering 18. Increased number of fruits 19. Increased number of fruits 20. Increased flowering 21. Sprouts earlier and usual 22. Increased production of water lilies	1. August to November 2. August to November 3. August to December 4. September to December 5. September to December 6. August to December 7. August to December 8. September to October 9. Not specified 10. August to October 11. August to October 12. August to October 13. August to October 14. August to October 15. From August 16. From August 17. August to November 18. From July 19. From July 20. January to February 21. Not specified 22. August to December

Meteorological indigenous warning signs for flooding

INDICATOR	CHICHEWA NAME	DESCRIPTION	PERIOD OBSERVED
Very hot temperatures	Kutentha kwamibri/ Ng'amba	Very hot temperatures, beddings are not needed when sleeping. People will sleep outside, and they sweat a lot during the day and at night. When it is hot, more rains come.	October to January
Heavy blowing of wind	Mphepo/ Bangula/ Mwera	Wind blowing heavily causing damages to houses (blowing off the loafs of the houses). Winds bring dust.	September to January
Northern wind	Mbalu/ Mpoto	Wind blowing from north to the south	December
Whirlwinds	Kavuluvula	The whirlwinds will occur increasingly	August to December
Fog occurrence	Nkhungu	Heavy fog on the mountain, especially the top part	November to December
Dark clouds	Mitambo yakuda	Dark clouds appear in the sky	November to January
Frequent blowing of winds	Kuzizila	Winds will blow frequently bringing some coldness	September to December
Rainfall intensity	Not specified	A lot of rainfall every day, rains come evenly distributed	December to March
Southern winds	Not specified	Not specified	
Changes in rainfall	Not specified	Men go to check and see how the rain is coming. They alert each other and if the rain starts in the morning they do not sleep and stay awake to see the water running.	December to March
White clouds	Not specified	White clouds that look like hills	October to March
Thick clouds	Not specified	When it is about to flood, clouds come out in large numbers and are thick	December to March
Stable clouds	Not specified	If the clouds are stable and settled in one place	Not specified

Riverine indigenous warning signs for flooding

INDICATOR	CHICHEWA NAME	DESCRIPTION	PERIOD OBSERVED
Sound of water from the river	Nthato ikama vumba mu m'ntisnje	The villagers will begin to head an increased sound movement of water from the river. Waters get loud	January

The rate of water levels increasing	Kukwera kwa madzi m'nstinje	The water levels in the rivers increase at a fast rate, villagers fail to cross the river. The riverbank gets full	January and February
Increased waste content in the river	Zinyalala madzi	More waste (e.g. grass) in the river	December to February
Use of tree branch as a water level monitoring equipment	Nthambi	Branch of any tree and dip it in the river, marked with different layers. When it reaches the upper layer, they know more water is coming	January and February
Water velocity	Not specified	Increased velocity, people can't pass a river	December to March
Water colours	Not specified	Waters are darker and muddier	December to March
Foaming in water	Not specified	Foam is created in waters	December to March
Water odour	Not specified	Odour coming out of the river	December to March
Debris in waters	Not specified	Increased debris content in the water	December to March
A backflow effect	Not specified	Streams flowing into Shire River have backflow effect	December to March
River beds dry up earlier	Not specified	It is a sign of an upcoming very rainy season	Not specified

Celestial indigenous warning signs for flooding

INDICATOR	CHICHEWA NAME	DESCRIPTION	PERIOD OBSERVED
Brightness of stars	Nyenyezi	The stars shine brighter than usually, they mostly appear in groups. In some places, stars shine less bright	November to December
A 'halo' around the moon	Chikwa/ Nkhokwe	The moon is surrounded by circle. It also indicates a bumper harvest	August to January
Orion star	Nthanda	Star shines bright from around 2 AM to 4 AM	October to December
Redness of the sun	Dzuwa	When sun is going down, around 4 to 5 AM, the villagers see more redness in the sky.	October to December
Sun intensity	Not known	Increased intensity of sun shining	Not indicated
Full moon	Phanda	Big moon at nigh indicates rains, and it comes with stars. Also stars 'fall across each other' from west- east	October to December
Brightness of the moon	Not known	When the moon does not shine with usual brightness	January

Direction of moon rising	Not known	When moon rises from the south, it indicates good rainfall	Not indicated

10 APPENDIX 3- Early action for flooding

Livelihood modification

Action	Action description	Period implemented
Change of planting place	As water levels are increasing, those that have farms near the river will change their planting place somewhere in the uplands.	A month to some days before floods
Changing planting practices	Only those who can afford it, they do it with the first rains	Not indicated
Shifting planting practices	Based on the observations, crops are planted earlier to avoid flooding- maize, cotton and Irish potatoes, millet	Not indicated

Food and fodder

Action	Action description	Period implemented
Food storage	Storing harvested food in bags to prevent it from getting moist.The villagers will build a raised stage called ‘sanja’ or ‘nthadala’ in their houses where all their crops and other foods are kept there so when the rains and floods come, their food and seeds will not be damaged. Some keep the food in the second house that has been constructed in the uplands	From two months before the flooding event
Food preservation for humans and animal	Villagers keep whatever they can. It depends on the amount of food they have. Keeping mainly maize. Food for family and livestock is kept in the sacks. Some also keep millet and sorghum, but it depends on the amounts available.	September to April
Message to store some food	Based on the IK warning signs, villagers will tell their fellow community members to store some food.	Not indicated

Livestock

Action	Action description	Period implemented
Raised platform for livestock	Building raised platforms 'kraals' for chicken and goats so they are not washed away.	From a month before the flooding event
Livestock relocation	Temporary move cattle to upland areas. Even though some of the livestock is moved away, it is never possible to relocate all of it. Relocation will take place when rains intensify. Hiring a shepherd to take care of livestock.	January and February
Livestock management	When they see the increased water levels, they will avoid feeding the cattle near to the river banks, to avoid being taken away by floods. Also increased presence of crocodiles, so to avoid the cattle being eaten.	From a month before the flooding event
Message to relocate livestock	People in the lowlands are advised to relocate their livestock	Starting from October

Relocation, evacuation and temporary houses

Action	Action Description	Period implemented
Evacuation	Based on the IK signs, people staying near the rivers might evacuate to an upland area, or evacuation centre (e.g. school and tents built by NGOs). Sometimes women and children, together with small livestock will evacuate while man stay in the lowlands in the raised platforms. Most of the people however wait for the waters to come and make an individual decision. Some people decide to stay and then they are affected.	From a month before the flooding event
Temporary shelters construction (chetes)	Temporary shelter made of wood and grass, they are raised. It is where children, women and small livestock take cover while men stay outside checking the level of water and making necessary maintenances on the shelter.	Not indicated
Message for relocation	People are told to move from the lowlands to the uplands	Not indicated
Constructing tents in the uplands (I can say this is also temporary shelter construction, but in the uplands)	Tents to evacuate once when the floods come.	Not indicated

Looking for a place to relocate	It can be the mountain or an ant hill	Immediately before the flooding event

Preparation of houses

Action	Action description	Period implemented
Preparation of houses	Changing roof plastics and adding grass to prevent any entry of water, strengthening the walls of houses with mud. Fixing the houses. Finding logs from trees for the roof, plastic papers against the leakage. The roofs are also fixed because heavy winds can take them away. Also raising the foundations by adding soil to it, thatching the houses. If funds available, some people will raise the house with burnt bricks and also add some cement. Strengthening by adding reeds	August to December

Message sharing

Action	Action description	Period implemented
Colour of the river waters	If the adults notice that the waters are dirty, they will say to their kids not to play close to the rivers, not to be washed away by floods.	During the flooding season
Not being close to the river	Based on the increased sounds coming from the waters and increasing water levels, the villagers will warn each other not to go close to the river; and also saying to kids if they hear those sounds, they should not go to school.	During the flooding season
EWS dissemination to the village	They warn people telling them with loud voice. Sending a message not to sleep that water is coming, that they should be alert and they should be awake.	Not indicated
Message to relocate food and livestock	People are advised to relocate food and livestock in the uplands.	August-December
Community mobilisation	Chiefs mobilise their people and inform them about flood indications.	Not indicated

Message to relocate to the uplands	Message for the community members living in the lowlands. They might have to rent houses in the uplands	Flooding season
Calling for meetings	Calling for meetings for those living in the lowlands	August- December

Other actions

Action	Action description	Period implemented
Family planning	Married couples find a way to prevent having more kinds to save more food in the house.	Not indicated
Making gullies	Building gullies to stop the waters.	Not indicated
Measuring water levels	Setting a stick in the waters and checking whether the water has reached a certain level. That happens right before the flood. Used to evaluate water levels. Using a reed or a tree branch.	Flooding season
Making of boats	For people that farm in the islands.	Not indicated
Observing water levels	Visual observation	Not indicated
Building a physical barrier to stop waters from the river.	Filling empty sacks with sand and placing them next to the river	October and November
River bank protection	Growing trees and grass on the river banks	Not indicated