Assessment of Food Security Early Warning Systems for East and Southern Africa

Final Report

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PREFACE

Disasters caused by climate extremes such as tropical cyclones and severe storms, floods, heat waves and droughts are jeopardizing Africa's hard-won development achievements towards further growth, food security and poverty reduction. In 2016 the food security situation deteriorated sharply in Africa–especially in East and Southern Africa—as a result of droughts and floods linked in part to El Niño/La Niña–related phenomena. The impacts are particularly felt in countries with the least capacity to respond due to over-reliance on rain-fed agriculture, high levels of poverty, inadequate access to financial capital and poor infrastructure.

Since the adoption of the Hyogo Framework for Action in 2005, evidence suggests that Early Warning Systems have generally been effective in alerting countries and stakeholders to impending hazards. However, the recurrence and magnitude of food crises in East and Southern Africa (ESA) underscore the need to improve prevention and response mechanisms in order to address the determinants and the dynamic nature of food insecurity, at both national and regional levels. Many countries in ESA have national platforms, legislation and policies on disaster risk reduction, but few address agriculture, food security and nutrition with sector-specific disaster risk reduction policies and objectives. Reducing risks and building resilience within agriculture requires a policy environment that is conducive to the full mainstreaming of disaster risk reduction within the sector.

There have been cases where inadequate analysis, together with poor communication and ineffective coordination and response mechanisms, have contributed to acute food security emergencies that might have been prevented. There are also concerns about the accuracy and reliability of some data, linkages of food security information to trade policy and private sector participation. Informing stakeholders and building consensus on the severity of food insecurity is vital, particularly in crisis situations to proactively reduce disaster losses in the sector, enable sector growth and protect the food security and nutrition of vulnerable populations. In-depth and regular information and analysis of food security vulnerability and resilience help countries to make better decisions and apply measures to protect and enhance their livelihoods.

In order to fulfill the commitments made towards Sendai Framework for Disaster Risk Reduction 2015–2030, it is critical that countries, regional organizations, development partners and private sector focus their collaborative efforts on creating and strengthening institutional mechanisms that guide the development of the EWS. This will enable EWS to more effectively meet the decision-making needs of their primary users and evolve in a dynamic and sustainable manner. EWS for food security programs should not be perceived as part of the emergency response activities. They should become part of an expanded food security information and analysis system that can produce viable, relevant and credible information necessary for responding to short- term emergencies as well as contributing to longer-term development programming.

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ACRONYMS AND ABBREVIATIONS

ACPC	African Climate Policy Centre
ADMAC	Agricultural Development and Marketing Corporation
ADPC	Asian Disaster Preparedness Center
AERR	ASEAN Emergency Rice Reserve
AFSIS	ASEAN Food Security Information System
AGRHYMET	Agriculture, Hydrology and Meteorology
ALP	Adaptation Learning Program
AMIC	Agricultural Marketing Information Center
ARC	African Risk Capacity
ASEAN	Association of Southeast Asian Nations
ASECNA	Agency for Aerial Navigation Safety in Africa and Madagascar
ASFR	ASEAN Food Security Reserve
ASI	Agricultural Stress Index
ATA	Agricultural Transformation Agency
AU	African Union
AWS	Automatic Weather Station
BCR	Benefit-Cost Ratio
CAADP	Comprehensive Africa Agriculture Development Program
CABI	Centre for Agriculture and Biosciences International
CBA	Community-based Adaptation
CCAFS	CGIAR Research Program on Climate Change, Agriculture and Food Security
CCBS	Country Cereal Balance Sheet
CEWARN	Conflict Early Warning and Response Mechanism
CFSAM	Crop and Food Security Assessment Mission
CGIAR	Consortium of International Agricultural Research Centers
CIMMYT	International Maize and Wheat Improvement Center *(Centro Internacional de Mejoramiento de Maíz y Trigo)*
COMESA	Common Market for Eastern and Southern Africa
CRBMF	Core River Basin Management Function
CSC	Climate Services Centre
DGM	General Directorate of Meteorology *(Direction Generale de la Meteorologie)*
DMMU	Disaster Management and Mitigation Unit
DRR	Disaster Risk Reduction
EAC	East African Community
EAGC	East African Grain Council
EARS	Environmental Analysis and Remote Sensing
ECCAS	Economic Community of Central African States
ENSO	El Niño - Southern Oscillation
EOC	Emergency Operation Center
EPA	Environmental Protection Agency
ESA	Eastern and Southern Africa
EU	European Union
EW	Early Warning
EWBMS	Energy and Water Balance Monitoring System
EWS	Early Warning System

FAMIS	Food and Agricultural Marketing Information System
FAO	Food and Agriculture Organization of the UN
FAW	Fall Armyworm
FESA	Food Early Solutions for Africa
FEWSNET	Famine Early Warning Systems Network
FPM	Focal Point Meeting
FPMA	Food Price Monitoring and Analysis
FRA	Food Reserve Agency
FSNAU	Food Security and Nutrition Analysis Unit
FSNWG	Food Security and Nutrition Working Group
GDP	Gross Domestic Product
GDPFS	Global Data Processing and Forecasting System
GFCS	Global Framework for Climate Services
GFDRR	Global Facility for Disaster Reduction and Recovery
GHACOF	Greater Horn of Africa Climate Outlook Forum
GIEWS	Global Information and Early Warning System on Food and Agriculture
GMB	Grain Marketing Board
GOS	Global Observing System
HDI	Human Development Index
HEWS	Humanitarian Early Warning Service
IASC	Inter-Agency Standing Committee
ICPAC	IGAD Climate Prediction and Applications Centre
IFRC	International Federation of Red Cross and Red Crescent Societies
IGAD	Intergovernmental Authority for Development
IITA	International Institute of Tropical Agriculture
INAM	Mozambique National Meteorology Institute *(Instituto Nacional de Meteorologia de* **Moçambique)**.
INAPFS	Integrated Agricultural Production and Food Security Forecasting System for East Africa
INFORM	Index for Risk Management
IOC	Indian Ocean Commission
IPC	Integrated Food Security Phase Classification
KAPAP	Kenya Agricultural Productivity & Agribusiness Project
KFSSG	Kenya Food Security Steering Group
KI	Key Informant
KII	Key Informant Interview
KMD	Kenya Meteorological Department
KMS	Kenya Meteorological Service
LEAP	Livelihoods, Early Assessment, and Protection
MAM	March, April, and May
MAS	Market Access Subgroup
MESA	Monitoring for Environment and Security in Africa
MIS	Market Information System
MoU	Memorandum of Understanding
MASA	Meteorological Association of Southern Africa
MSD	Meteorological Service Department

NAPIHMS	National Action Plan for Improvement of Hydrometeorological Services
NASFAM	National Small Holder Farmers Association of Malawi
NDVI	Normalized Difference Vegetation Index
NFBS	National Food Balance Sheet
NFBSC	National Food Balance Sheet Committee
NGO	Nongovernmental organization
NMHS	National Meteorological and Hydrological Service
NHS	National Hydrological Service
NMS	National Meteorological Service
NPV	Net Present Value
NVAA	National Vulnerability Assessment and Analysis
NVAC	National Vulnerability Assessment Committee
NWS	National Weather Service
O&M	Operation and Maintenance
PAD	Project Appraisal Document
PAGASA	Philippine Atmospheric Geophysical and Astronomical Services Administration
PPP	Public-Private Partnership
PSP	Participatory Scenario Planning
RATIN	Regional Agriculture Trade Intelligence Network
REC	Regional Economic Community
RFBS	Regional Food Balance Sheet
RIASCO	Regional Inter-Agency Standing Committee
RIIS	Regional Integrated Information System
RIMES	Regional Integrated Multi-Hazard Early Warning System
RSMC	Regional Specialized Meteorological Centre
RVAA	Regional Vulnerability Assessment and Analysis
RVAC	Regional Vulnerability Assessment Committee
SACU	Southern African Customs Union
SADC	Southern African Development Community
SARCOF	Southern African Regional Climate Outlook Forum
SDG	Sustainable Development Goal
SFDRR	Sendai Framework for Disaster Risk Reduction
SGR	Strategic Grain Reserve
SOP	Standard Operating Procedure
SMS	Short Message Service
SWC	Severe Weather Consult
TAHMO	Trans-African Hydro-Meteorological Observatory
TMA	Tanzania Meteorological Agency
ToT	Terms of Trade
UN	United Nations
UNECA	United Nations Economic Commission for Africa
UNISDR	United Nations International Strategy for Disaster Reduction
VAA	Vulnerability Assessment and Analysis
VAC	Vulnerability Assessment Committee
VSL	Value of a Statistical Life

WFP	World Food Programme
WIBI	Weather Index-Based Insurance
WMO	World Meteorological Organization
WTP	Willingness to Pay
ZEPRIS	Zambia Emergency Preparedness Information System
ZFU	Zimbabwe Farmers' Union
ZMD	Zambia Meteorological Department

EXECUTIVE SUMMARY

The risk[1] of the El Niño-induced food insecurity in southern Africa in 2016, the recent risk of famine in northern Kenya, Somalia, Ethiopia, and South Sudan, and the recent outbreak of the Fall Armyworm (FAW) in East and Southern Africa (ESA) all demonstrate that responses are still largely reactive than proactive. Inadequate Early Warning System (EWS), coupled with limited investment and weak institutional and technical capacity, are implicated in contributing to food insecurity-related emergencies in ESA. Yet, over the years, strong evidence has emerged on the benefits of investing in EWSs. In Ethiopia, investing in a drought EWS, which would reduce livelihood losses and dependence on assistance, has a benefit-cost ratio (BCR) of between 3:1 and 6:1. Similarly, the BCR of improving national hydrometeorological services in developing countries ranges from 4:1 to 36:1. Consistent with one of the goals of the Sendai Framework for Disaster Risk Reduction (SFDRR), increasing investment in EWSs would contribute to a substantial increase in the availability of, and access to multi-hazard[2] and disaster risk information, one of the key inputs in achieving the Sustainable Development Goals (SDGs).

In supporting these efforts, an assessment of food security EWSs was conducted to improve food security and resilience[3] in eastern and southern Africa. The study aimed at assessing ‘bottlenecks’ and opportunities for improving food security EWSs for enhanced resilience in ESA. The performance, and capacity of EWSs at the Regional Economic Cooperation level and at sampled member states were assessed. The study drew lessons from the Association of Southeast Asian Nations (ASEAN) region particularly in relation to EWS policies, investments, and technical capacities. As the assessment attempted to be as comprehensive as possible, it was essential to also draw lessons from programs and projects being piloted on EWSs, including those being implemented by the World Bank such as those in Malawi, Zambia, Zimbabwe, Kenya, Somalia, Tanzania, and Mozambique.

While progress has been made, there are challenges that recur across the Regional Economic Communities (RECs) and member states and fall into three main categories:

Institutional Challenges

- Lack of EWS working groups in both RECs to coordinate EWS activities. In the Intergovernmental Authority for Development (IGAD) region, the institutionalization of the Food Security and Nutrition Working Group (FSNWG) has been slow because the FSNWG is yet to be endorsed as an institution of IGAD.

[1] **‘Risk’** is used here to mean the potential for consequences where something of value is at stake and where the outcome is uncertain, recognizing the diversity of values. Risk is often represented as the probability of occurrence of hazardous events or trends multiplied by the consequences if the events occur. Risk results from the interaction of vulnerability, exposure, and hazard (IPCC 2014).
[2] **‘Hazard’** is the potential occurrence of a natural or human-induced physical event or trend, or physical impact, that may cause loss of life, injury, or other health impacts, as well as damage and loss to property, infrastructure, livelihoods, service provision, and environmental resources (IPCC 2014).
[3] **‘Resilience’** means the capacity of a social-ecological system to cope with a hazardous event or disturbance, responding or reorganizing in ways that maintain its essential function, identity, and structure, while also maintaining the capacity for adaptation, learning, and transformation (IPCC 2014)

- Policies that outline roles and responsibilities for EWS actors at both regional and national levels are generally weak. Although many ESA countries have sector policies, the sectors still operate in silos due to lack of overarching EWS policies. In addition, although several tools such as the Integrated Food Security Phase Classification (IPC) have manuals that guide users, these have not been endorsed by regions and member states to provide guidance on systematic data collection, data sharing, monitoring, and agreed action triggers.

- Although the Greater Horn of Africa Climate Outlook Forum (GHACOF) report is more on the actions that users need to consider compared with the Southern African Regional Climate Outlook Forum (SARCOF) reports, which are still expressed in probabilities, some users such as pastoralists are still excluded because the reports are in English that they do not understand. While the start and end dates for the season are useful, there is still a gap on the intensity and frequency and for the information to reach some of the users.

- Lack of regular updates of the regional food balance sheets (RFBSs) and national food balance sheets (NFBSs) and weak monitoring of grain markets, cross-border trade, commodity price monitoring. Although the Famine Early Warning Systems Network (FEWSNET) and the World Food Programme (WFP) actively monitor these activities, integration of some of these into regional and national systems is still limited.

Technical Challenges

- While the SARCOF and GHACOF processes are well established in providing regional climate forecasts, there are still challenges to downscale these forecasts to local levels such as districts or villages. Another limitation of GHACOF and SARCOF is that they tend to focus on rain and pay little attention to other weather parameters.

- Limited coverage of the weather observation networks and challenges in crop production forecasts makes agrometeorology data less reliable. The capacity of national meteorological and hydrological services[4] (NMHSs) in Africa is not adequate and considerably degraded in some countries during the last 20–25 years.

- In some countries, there is a lack of technically qualified professionals such as meteorologists, agrometeorologists, and hydrometeorologists to ensure quality hydrometeorological products.

- Although the Vulnerability Assessment Committee (VAC) system has become one of the most useful and reliable EWSs tool in the Southern African Development Community (SADC), there are multiple methodologies that need harmonization. Similarly, the IPC, which continues to gain currency there, has challenges in the comparability of outcome indicators because some countries use actual food security outcome indicators while others make inferences without the actual data.

[4] **'National Meteorological and Hydrological Service'** refers to a National Meteorological Service (NMS) or National Hydrological Service (NHS), or an organization that combines the functions of both (WMO 2012a). The plural, NMHSs, refers to multiple organizations (NMHS, NMS, and NHS).

- Weak food security information systems and absence of a framework for sharing data at both the regional and national levels makes EWS information slow to reach users.

Sustainability and Financial Challenges

- There are no clear funding mechanisms for EWSs. The reason is that EWS programs take a reactive rather than a proactive approach. Consequently, as early warning (EW) is considered as an emergency response activity, the funding tends to be ad hoc and therefore competes with development funds during emergency response. In addition, because EWSs rely on international assistance, which tends to be project-based, they often face the problem of financial sustainability once external funding ceases. Instead, EWSs should be considered as part of regular development because EWS data are used for planning interventions.

- There is limited public-private partnership (PPP) with private climate services providers yet such partnerships would reduce reliance on donors. There is uncertainty over the nature of the relationship between the NMHSs and private sector. There is also a perception that the private sector may be a threat to job security, data security and ownership, and government obligations to supply public goods[5] such as EWs.

RECOMMENDATIONS

Key priority recommendations for targeted investment are outlined below.

- **Develop and strengthen the Food Security Information System** at both national and regional levels to meet the RECs, AU, and member states agendas, including the CAADP. The information should contribute to ongoing development programs, as well as for improving the effectiveness of the EWSs, emergency preparedness and response capacity. The RECs in the ESA region should consider establishing a Food Security Information System, taking into consideration lessons learned from similar initiatives, including the AFSIS to strengthen food security EWSs. This effort should be supported by a data sharing framework and a one-stop food security information hub such as EOC that is accessible to relevant stakeholders, including government agencies, and the international community. The regional Food Security Information System should also be replicated in each of the member states.

- **Support the strengthening of the EWS legal, regulatory and institutional frameworks as well as improving coordination** and ensuring clarity of roles and responsibilities within and across the four components of effective EWSs. This will include developing common methodologies and procedures for data collection, management, and data sharing across geographical borders, as well as developing effective strategies for the timely dissemination of actionable warnings.

[5] A **'public good'** is a good that no consumer can be excluded from using if it is supplied and for which consumption by one consumer does not reduce the quantity available for consumption by any other. The first property is referred to as non-excludability, whereas the latter is termed non-rivalry (Black et al. 2017).

- **Promote south-south knowledge exchanges.** For example, exchange of information between AFSIS and RECs in the process of developing their Food Security Information Systems. Inter-REC knowledge exchanges such as Agriculture, Hydrology and Meteorology (AGRHYMET) Regional Centre of the countries of the Permanent Inter-State Committee for Drought in the Sahel (CILSS) could also be considered.

- **Invest in technical capacity development to enable the collection of high-quality agrometeorological crop production forecasts and vulnerability data.** EWSs require (a) improved capacity to downscale global and regional climate forecasts to high resolution for the forecasts to be meaningful at the local level; (b) strong weather observation networks with a wider coverage; and (c) improved data collection for crop assessments, livestock assessments, and vulnerability assessments. The SADC's Vulnerability Assessment and Analysis (VAA) as well as the IPC methodologies should be harmonized or at least agree on minimum indicators to ensure quality assurance and comparison among countries.

- **Strengthen public commitment and mainstream EWS considerations into agricultural/food security policies, budgetary allocations, and planning frameworks.** This will require evidence-based advocacy to national, regional leaders and cooperation development partners on the economic benefits of EWSs.

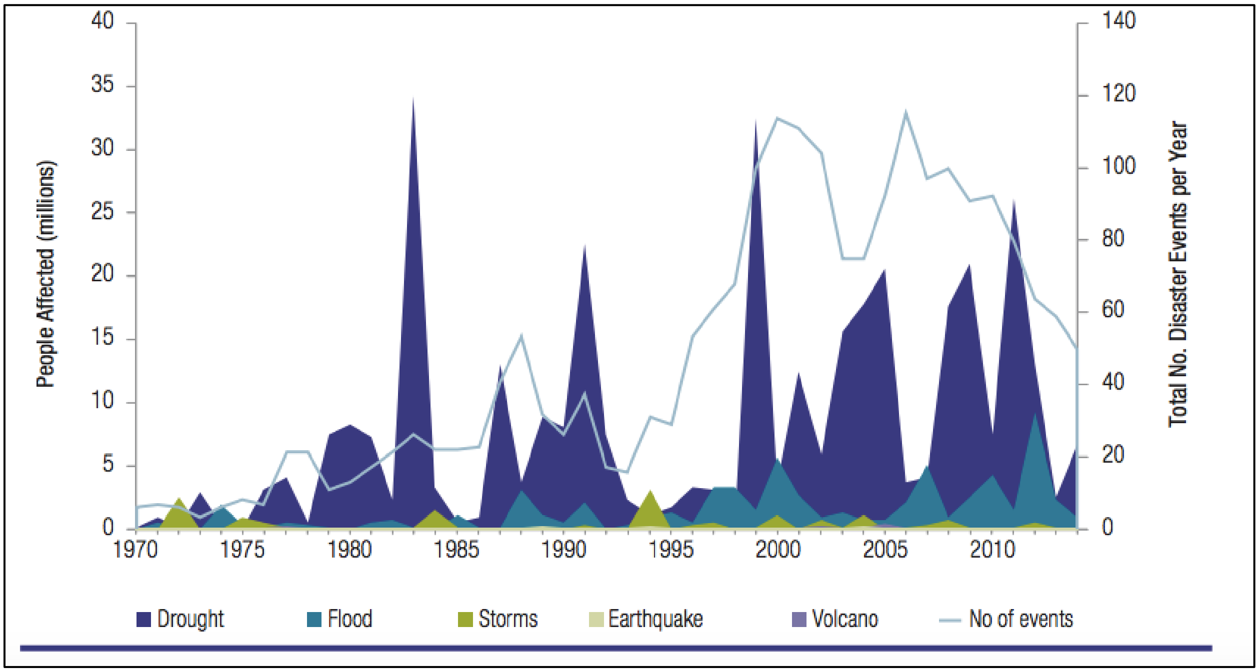
- **Support the development of tools to support vulnerable households and communities** to establish household community systems that can respond to emergencies.

CHAPTER ONE: THE IMPERATIVE OF EARLY WARNING[6] SYSTEMS IN EASTERN AND SOUTHERN AFRICAN REGIONS

1.1 Background

A common understanding has emerged over the decades, particularly since 2000, that disasters mainly triggered by hydrometeorological hazards have become a constant occurrence in Sub-Saharan Africa (Figure 1.1). These hazards are manifested in the El Niño - Southern Oscillation (ENSO), the largest mode of interannual variability in the climate system (Murphy et al. 2001), whose frequency has increased in the countries of Eastern and Southern Africa (ESA).[7]

Figure 1.1: Number of Reported Disasters and People Affected by Disaster Type in Sub-Saharan Africa



Source: GFDRR 2016, 1.

There is strong evidence that higher temperatures, droughts, floods, and changing weather[8] patterns expected from climate change will exacerbate the disaster risks associated with

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[6] **'Early Warning'** is the provision of timely and effective information, through identified institutions, that allows individuals exposed to a hazard to take action to avoid or reduce their risk and prepare for effective response (UNISDR 2009). In this study, although EWSs are adopted, experience shows that EWSs alone do not prevent hazards turning into disasters. Early action is essential, particularly given the increasing accuracy of seasonal forecasts. However, even with timely EWs and planned early action, people suffer the disastrous consequences of natural hazards.

[7] The east African countries, under the IGAD region, are Burundi, Eritrea, Ethiopia, Djibouti, Kenya, Rwanda, Somalia, South Sudan, Sudan, and Uganda. The southern African countries, under the SADC are Angola, Botswana, Democratic Republic of Congo, Lesotho, Madagascar, Malawi, Mauritius, Mozambique, Namibia, Seychelles, South Africa, Swaziland, Tanzania, Zambia, and Zimbabwe.

[8] **'Weather** refers to atmospheric phenomena that have timescales that range from hours to days to one or two months, whereas **'climate'** refers to atmospheric conditions that have timescales that range from a few months to a season to a year to a decade or more, or even longer. In this sense, the terms 'weather' and 'climate' identify regions along a continuous spectrum of atmospheric conditions, weather describing rapidly changing events, and climate describing

hydrometeorological hazards (Figure 1.2 and Box 1.1). The adverse impact of ENSO events is exacerbated by chronic environmental and socio-economic conditions that compound to worsen food insecurity conditions across ESA. Improved regional and national weather, water and climate-related monitoring and forecasting capabilities contribute to enhancing EWSs, including those focused on food security. Adverse weather and climate conditions, such as those triggered by ENSO events, can affect entire regions. Governments can use improved monitoring and forecasting for improving and protecting agricultural productivity and production; contributing to protecting lives and the livelihoods of those households engaged in agriculture and other climate-sensitive-sectors.

Figure 1.2: Summary of Climate Impacts and Risks in Sub-Saharan Africa

Risk/Impact		Observed Vulnerability or Change	Around 1.5°C[A,B] (≈2030s[C])	Around 2°C (≈2040s)	Around 3°C (≈2060s)	Around 4°C (≈2080s)
Heat extreme[D] (in the Southern Hemisphere summer) Drought	Unusual heat extremes	Virtually absent	20–25 percent of land	45 percent of land	70 percent of land	>85 percent of land
	Unprecedented heat extremes	Absent	<5 percent of land	15 percent of land	35 percent of land	>55 percent of land
		Increasing drought risk in Southern, Central, and West Africa, decrease in East Africa, but West and East African projections are uncertain	Likely risk of severe drought in Southern and Central Africa, increased risk in West Africa, decrease in East Africa but West and East African projections are uncertain	Likely risk of severe drought in southern and Central Africa, increased risk in West Africa, decrease in East Africa but West and East African projections are uncertain	Likely risk of extreme drought in Southern Africa and severe drought in Central Africa, increased risk in West Africa, decrease in East Africa, but West and East African projections are uncertain	Likely risk of extreme drought in Southern Africa and severe drought in Central Africa, increased risk in West Africa, decrease in East Africa, but West and East African projections are uncertain
Aridity		Increased drying	Little change expected	Area of hyper-arid and arid regions grows by 3 percent		Area of hyper-arid and arid regions grows by 10 percent. Total arid and semi-arid area increases by 5 percent
Sea-level rise above present (1985–2005)		About 21 cm to 2009[E]	30cm[F]-2040s 50cm-2070 70cm by 2080–2100	30cm-2040s 50cm-2070 70cm by 2080–2100	30cm-2040s 50cm-2060 90cm by 2080–2100	30cm-2040s 50cm-2060 105cm by 2080–2100

[A] Refers to the global mean increase above pre-industrial temperatures.
[B] Years indicate the decade during which warming levels are exceeded in a business-as-usual scenario exceeding 4°C by the 2080s.
[C] Years indicate the decade during which warming levels are exceeded with a 50 percent or greater change (generally at the start of the decade) in a business-as-usual scenario (RCP8.5 scenario). Exceedance with a likely chance (>66 percent) generally occurs in the second half of the decade cited.
[D] Mean heat extremes across climate model projections are given. Illustrative uncertainty range across the models (minimum to maximum) for 4°C warming are 70–100 percent for unusual extremes, and 30–100 percent for unprecedented extremes. The maximum frequency of heat extreme occurrence in both cases is close to 100 percent, as indicator values saturate at this level.
[E] Above 1880 estimated global mean sea level.
[F] Add 20 cm to get an approximate estimate above the pre-industrial sea level.

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slowly changing ones. Climate can be represented in terms of a normal, long-term average, and year-to-year fluctuations—the interannual variability—around which that average when viewed over a period of a few hundreds of years, has fallen within a bounded 'range' of values. Common drivers of climate variability are the oscillations that occur in Earth's coupled ocean-atmosphere system. An example is the El Niño and La Niña (ENSO) events, shifts of warm, tropical Pacific Ocean currents that can dramatically affect seasonal weather patterns around the world. Other drivers include volcanic eruptions and solar phenomena. Sometimes climate varies in ways that suggest a component of randomness being inherent in Earth's climate system. **'Climate change'** is a long-term continuous change (either increase or decrease) in a climate normal (for example, an increase in the long-term average temperature) and/or the range of climate variability (for example, more frequent, more intense thunderstorms together with fewer small showers). As the range increases, the year-to-year variations in a variable such as temperature or precipitation should be expected to be greater, and so new extreme values are likely.

Source: UNDP 2016, 6.

Box 1.1: Projected Climate Change Impacts in Sub-Saharan Africa

With 4°C of global warming by the end of the century, sea level is projected to rise up to 100 cm, droughts are expected to become increasingly likely in central and southern Africa, and never-before-experienced heat extremes are projected to affect increasing proportions of the region.

Projections also show a growing probability of increased annual precipitation in the Horn of Africa and parts of east Africa, which is likely to be concentrated in heavy downpours and, thereby, increase the risk of flooding.

Sub-Saharan Africa is particularly vulnerable to impacts on agriculture. Most of the region´s agricultural crop production is rainfed and, therefore, highly susceptible to shifts in precipitation and temperature. A net expansion of the overall area classified as arid or hyperarid is projected for the region as a whole, with likely adverse consequences for crop and livestock production.

Savannah grasslands may be reduced in area, with potential impacts on livelihoods and pastoral systems. By the time global warming reaches 3°C, savannahs are projected to decrease from about a quarter at present to approximately one-seventh of the total land area, reducing the availability of food for grazing animals.

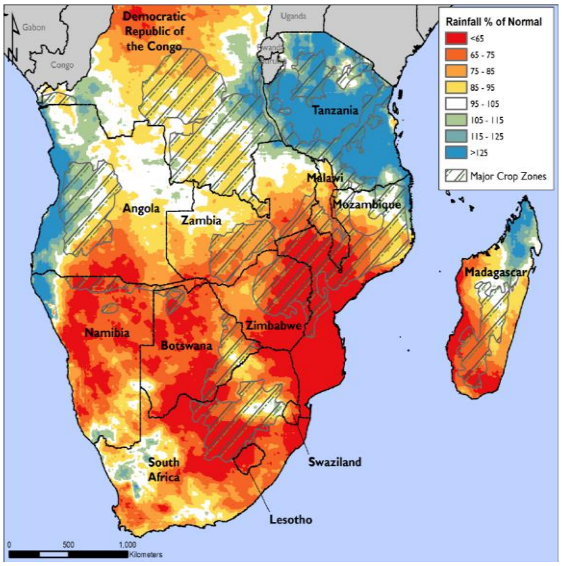
Source: UNDP 2016, 5–6.

The observed shifting patterns in weather and climate have caused rainfall anomalies in ESA countries (Figure 1.3), with these shifts having their impact on agriculture, health, migration, and conflict exacerbating existing vulnerabilities. Weather- and climate-related hazards combined with social vulnerability[9] drivers, pose a threat to lives, livelihoods, economic activities, and socioeconomic assets. The major agricultural vulnerability drivers include poor agricultural production, loss of livestock, high food prices, cross-border trade barriers, growing economic interdependence, poverty, and civil conflict. The drought and floods of the 2015–16 El Niño phenomena crippled agricultural production in a number of ESA countries, exacerbating chronic food insecurity in some regions, and triggering acute food insecurity in others, threatening millions of vulnerable households (Figure 1.4).

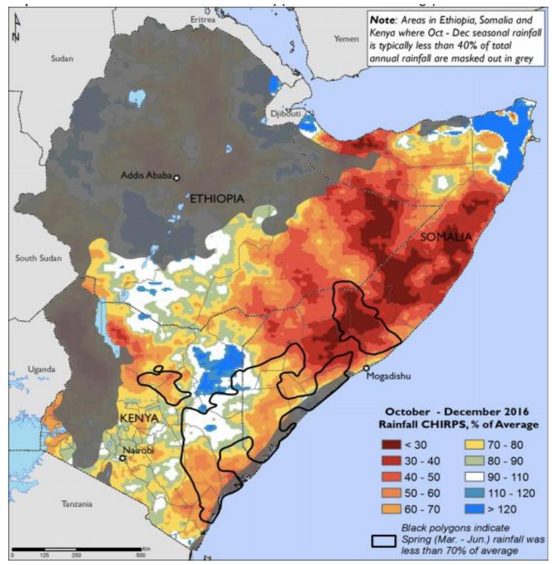
[9] **'Vulnerability'** is the propensity or predisposition to be adversely affected. It encompasses a variety of concepts including sensitivity or susceptibility to harm and lack of capacity to cope and adapt (IPCC 2014).

Figure 1.3: Rainfall Anomalies in ESA

October 2015–February 2016 Rainfall Anomalies (percent of the 1982–2011 Average) for Southern Africa



October–December 2016 Rainfall Anomaly (percent of the 1981–2010 Average) for East Africa



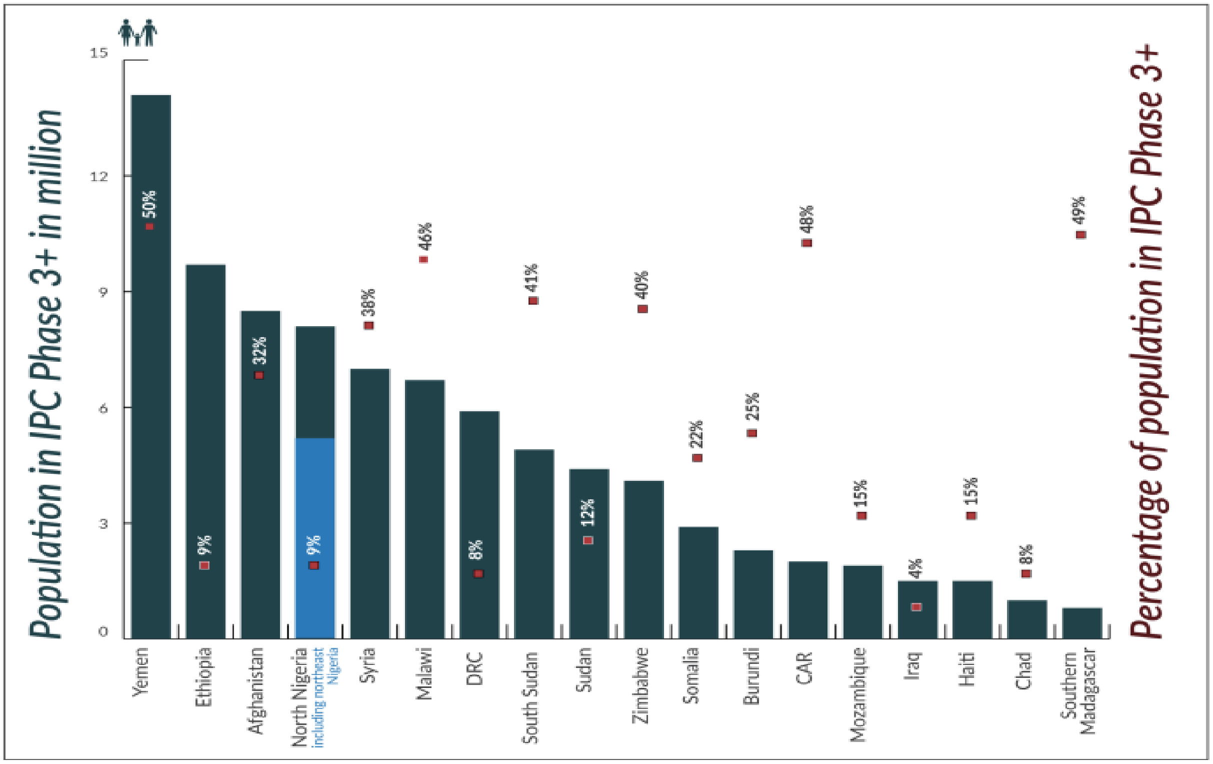
Source: FEWSNET 2016, 2017.

The climate anomalies have wide-ranging impacts in ESA. Although globally 108 million people from 18 countries faced crises-level food insecurity or worse in 2016 (Integrated Food Security Phase Classification [IPC] Phase 3 and above), 10 of these countries were from ESA (Figure 1.4). What distinguishes the ESA countries from the rest of the world is the extent to which food security[10] has been undermined by a combination of El Niño-induced drought conditions and conflict. Climate variability and change, along with weather extremes and conflict have put pressures on food production, marketing, and humanitarian systems at a time when resources and capacity are already strained.

Projections for early 2017 indicate an increase in the severity of food insecurity in these regions, particularly in Ethiopia, Kenya, and Somalia .

[10] For consistency with the global conceptualization of food security, the 1996 World Food Summit definition of food security is adopted as "Food security at the individual, household, national, regional and global levels [is] when all people, at all times, have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life" (FAO 1996). In this case, food security is the absence of, among others, food insecurity, hunger, starvation, and nutrition insecurity. Food security metrics, which also form the basis for EWSs, should at minimum consider understanding the hazards vulnerabilities, which affect food availability, access, utilization, or some combinations of these metrics, considering social and cultural dimensions. For this assessment, a combination of food balance sheet approaches, physical and economic access, utilization (in terms of nutrition), and the social and cultural aspects (in terms of governance) are considered.

Figure 1.4: Food Security IPC Crisis Phase 3 and above (January 2017)

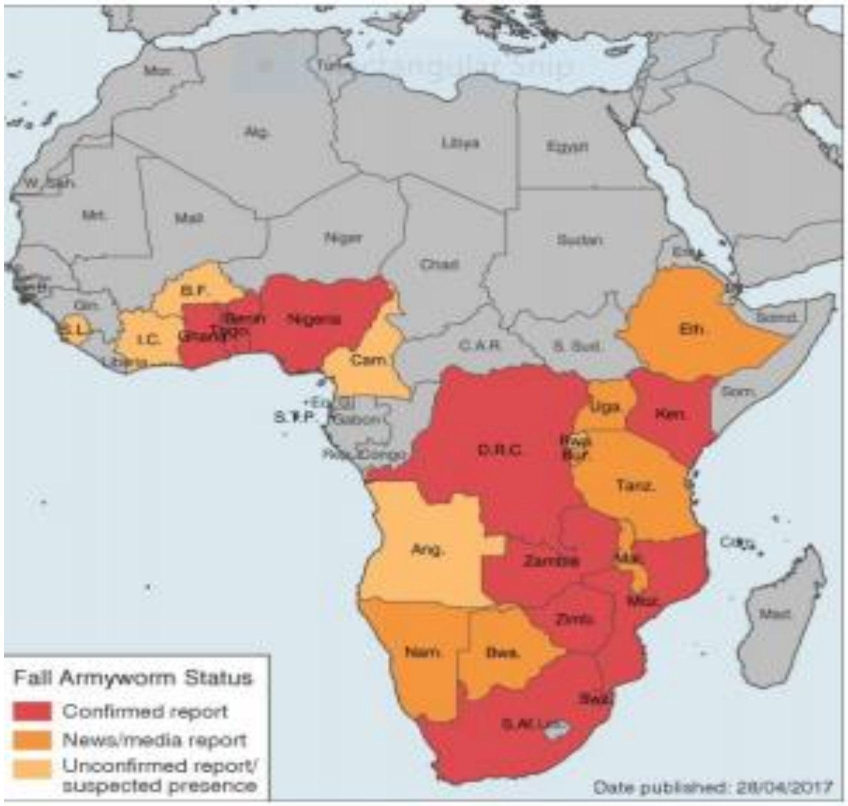


Source: FSIN 2017, 17.

The recent food crisis in ESA demonstrates that responses are still largely reactive rather than proactive. In 2016, the southern African region has experienced a historic El Niño-induced drought, which triggered a food crisis that has been described as the worst in 35 years. Approximately 40 million people were in need of humanitarian assistance, and about 2.7 million children were suffering from malnutrition in the subregion. There was a cereal production shortfall of approximately 9.3 million tons. As a result, the South African Development Community (SADC) declared a state of regional disaster in June 2016 and appealed for US$2.4 billion for the support of the humanitarian needs of the affected population (SADC 2016a).

The pressure on food security in Sub-Saharan Africa is likely to be further exacerbated by the recent threats of the Fall Armyworm (FAW) (*Spodoptera frugiperda*) outbreak (Figure 1.5), which may be related to warmer global temperatures over the past few years (CIMMYT 2017). Environmental and climatic analyses of Africa show that the FAW is likely to build permanent and significant populations in west, central, and southern Africa and spread to other regions when weather or temperatures are favorable. Prediction models so far present much uncertainty as scientific institutions are still learning of the pest's habits and environmental suitability on the continent (Abrahams et al. 2017).

Figure 1.5: Known and Suspected Distribution of FAW in Africa (April 2017)



Source: Abrahams et al. 2017.

Notwithstanding the limited scientific knowledge on the FAW in Africa, in 2016, the FAW was identified in 11 countries and was suspected in at least 14 other countries. The economic impact of the FAW on maize, sorghum, rice, and sugarcane in Africa is estimated to be approximately US$13,383 million (Table 1.1). This does not consider up to 80 other crops the insect has been known to feed on, as well as subsequent seeds lost for the following growing seasons. If the FAW threat materializes, this will likely put further pressure on food security.

Table 1.1: Estimated Economic Impact of the FAW

FAW affected crops in all countries	Total production (million tons) assuming no FAW	Yield loss (million tons)	Estimated/predicted loss (US$, million)
Maize	67.0	13.5	3,058
Sorghum	25.5	1.9	827
Rice, paddy	17.1	9.6	6,699
Sugarcane	90.1	46.0	2,799
		Total	**13,383**

Source: Abrahams 2013.

The observed and projected impacts of a changing climate on food security in the ESA countries, exacerbated by evolving threats, e.g. pest infestations such as FAW, are projected to worsen existing social vulnerabilities; highlighting the urgent need for improving the effectiveness and efficiency of Early Warning Systems (EWSs). Inadequate EWSs and existing gaps in the effective flow of information across agencies and among levels of government administration hinder the governments' capacity to prepare and respond to food insecurity-related emergencies in ESA countries (Tadesse et al. 2008). It is hypothesized that having effective EWS and adequate communication systems in place for the dissemination of actionable warnings to the targeted audiences, the impact of the El Niño-induced drought could have been less severe in the ESA region. A growing body of evidence shows that effective EWSs not only save lives but also help protect livelihoods and enhance national development gains (United Nations, 2006).

Only a few cost-benefit analyses[11] of EWSs have been carried out in developing countries. However, those so far completed provide strong evidence on the benefits of investing in establishing and improving EWSs. For instance, Hallegatte's 2012study, although focused on the hydrometeorological information production element of EWSs, without the social vulnerability information postulates that if hydrometeorological and early warning (EW) capacity in all developing countries were upgraded to the level of developed country standards, such investments would result in at least three potential benefits:

- Avoidable asset losses of between US$300 million and US$2 billion per year due to natural hazards;
- Avoidable human losses of about 23,000 per year, estimated between US$700 million and US$3.5 billion per year; and
- Economic benefits between US$3 billion and US$30 billion per year with benefit-cost ratios (BCRs) between 4 and 35 with co-benefits

While the ESA countries and their regional bodies have made efforts in developing EWSs,[12] there is still a gap in investing in EWSs to enhance preventive, anticipatory, and absorptive capacity to food insecurity.

Investing in EWSs, including cost-benefit analysis, is explored in further detail in Chapter Four.

Similarly, a number of studies have been conducted on the status of food security EWSs, for example, (Tefft et al. 2006) and UNECA (2011). Their assessment of food security EWSs in sub-Saharan Africa took note of the well-known challenges of effective food security EWSs that were also highlighted by numerous studies related to an overly technical approach, externally imposed methods and institutional models, and short-term project horizons. They, however, attribute the primary cause of lack of progress in EWSs to insufficient attention to, and inadequate investment

[11] **'Benefit-cost analysis'** or **'cost-benefit analysis'** is the quantification of the total social costs and social benefits of a policy or a project, usually in monetary terms. The costs and benefits concerned include not only direct pecuniary costs and benefits, but also externalities, meaning external effects not traded in markets. These include external costs, for example, pollution, noise, and disturbance to wildlife, and external benefits such as reductions in travelling time or traffic accidents. Benefit-cost analysis is often used to compare alternative proposals. If the total social benefits of an activity exceed total social costs, this can justify subsidizing projects that are not privately profitable. If the total social costs exceed total social benefits, this can justify preventing projects even when these would be privately profitable (Black et al. 2017).

[12] This includes the Regional Agriculture Trade Intelligence Network (RATIN) in east Africa and Regional Vulnerability Assessment and Analysis (RVAA).

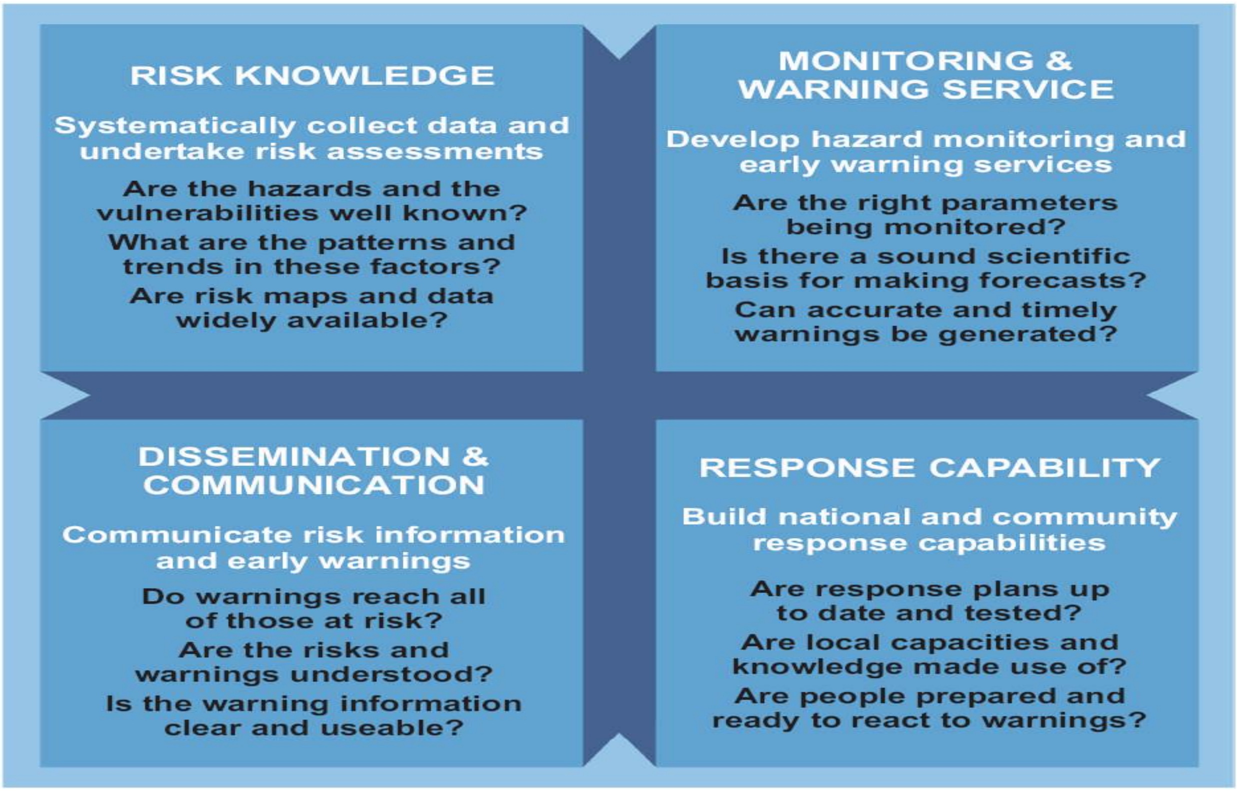
in, developing institutional mechanisms and capacity for an effective, sustainable, and demand-driven EWS. The United Nations Economic Commission for Africa (UNECA) study that focused on enhancing the effectiveness of Food Security Information Systems in the SADC region recommended the need for strengthening, as well as integrating food security information systems, harmonizing methodologies, strengthening partnerships, building capacity, creating financial and institutional sustainability, and strengthening communication and dissemination, all of which are critical to an effective EWS. The findings of these studies are by no means less important. With increasing exposure and susceptibility of the agriculture systems to climate change and variability, it is critically important to regularly update the EWS knowledge base to appropriately respond to the changing nature of risk. Besides, the 2014 Malabo Declaration of the African Union (AU), which recommitted the member states to adopt the Comprehensive Africa Agriculture Development Program (CAADP) process and to ending hunger and take action of improving nutrition by 2025, recognizes the importance of EWSs. The Malabo Declaration encourages the member states to commit budget lines within their national budgets for strengthening EWSs to facilitate advanced and proactive responses to disasters and emergencies with food and nutrition security implications.[13] More importantly, an increase in the availability of and access to multi-hazard EWSs and disaster risk information and assessments to the communities by 2030 is one of the key interventions needed for achieving the goals of the Sendai Framework for Disaster Risk Reduction (SFDRR) and Sustainable Development Goals (SDGs). This recommendation has been further supported by the Yaoundé Declaration on the Implementation of the Sendai Framework in Africa of 2015 and the Mauritius Declaration on the Implementation of the Sendai Framework in Africa of 2016.

1.2 Four Elements of an Effective People-centered Early Warning

To comprehensively analyze the data from the stakeholders' consultations, the four commonly cited elements of EWSs (Basher 2006; IFRC 2009) were adopted (Figure 1.6). UNISDR (2006) argues that a complete and effective EWS comprises four interrelated elements, spanning knowledge of hazards and vulnerabilities to preparedness and capacity to respond.

[13] More details on the Malabo Declaration can be found at https://www.au.int/web/sites/default/files/documents/31247-doc-malabo_declaration_2014_11_26.pdf

Figure 1.6: Elements of an EWS



Source: UNISDR 2006.

1.2.1 Risk Knowledge

Understanding risk and the risk drivers, as emphasized by the SFDRR, is the first step toward building effective EWSs. Risks arise from the combination of hazards, exposure, and vulnerabilities at a location. Assessments of risk require systematic, standardized collection and analysis of data and should consider the dynamic nature of hazards and vulnerabilities that arise from processes such as urbanization, rural land-use change, environmental degradation, and climate change. Risk assessments and maps help motivate people, prioritize EWS needs, and guide preparations for disaster prevention and responses.

1.2.2 Monitoring and Warning Service

Warning services lie at the core of the system. There must be a sound scientific basis for predicting and forecasting hazards and a reliable forecasting and warning system that operates 24 hours a day. Continuous monitoring of hazard parameters and precursors is essential to generate accurate warnings on time. Warning services for different hazards should be coordinated where possible to gain the benefit of shared institutional, procedural, and communication networks.

1.2.3 Dissemination and Communication

Warnings must reach those at risk. Clear messages containing simple, useful information are critical to enable proper responses that will help safeguard lives and livelihoods. Regional-, national-, and community-level communication systems must be pre-identified and appropriate authoritative voices established. The use of multiple communication channels is necessary to ensure as many people as possible are warned, to avoid failure of any one channel, and to reinforce the warning message.

1.2.4 Response Capability

It is essential that communities understand their risks, respect the warning service, and know how to react. Education and preparedness programs play a key role. It is also essential that disaster management plans are in place, well-practiced, and tested. The community should be well informed on options for safe behavior, available escape routes, and how best to avoid damage and loss to property.

Best practice EWSs also have strong interlinkages and effective communication channels between all the elements. The four elements of EWSs need to be coordinated across many agencies at national to local levels for the system to work. Failure in one element or lack of coordination across them could lead to the failure of the entire system. The issuance of warnings is a national responsibility; thus, roles and responsibilities of various public and private sector stakeholders for implementation of an EWS should be clarified and reflected in the national to local regulatory frameworks, planning, budgetary, coordination, and operational mechanisms.

1.3. Purpose and Scope of the Report

This report presents the findings and recommendations of the regional assessment of the EWSs for enhancing food security in ESA. The objective of the assignment was to assess 'bottlenecks' and opportunities for improving food security EWSs to enhance resilience in ESA, which comprises 25 countries and five African Union's Regional Economic Communities (RECs).[14] EWS producers and users, drawn from government and nongovernment agencies as well as local communities, were consulted in 7 out of 25 countries in east (includes members of the East African Community (EAC) and Intergovernmental Authority for Development (IGAD) and southern Africa (includes member states from the SADC and Indian Ocean Commission [IOC]). All members of these RECs are also members of the Common Market for East and Southern Africa (COMESA). The country selection criterion was based on the level of disaster risk, according to the Index for Risk Management (INFORM) classification[15]. The INFORM index is a measure based an assessment of the countries' hazard exposure, vulnerability, lack of coping capacity, and on the level of development using the Human Development Index (HDI) (Table 1.2). This assessment also drew lessons learned from initiatives across the Association of Southeast Asian Nations (ASEAN) region, particularly in relation to EWS policies, investments, and technical assistance.

[14] There are seven RECs in ESA. Of these, five are recognized by the AU: EAC, SADC, IGAD, COMESA, and Economic Community of Central African States (ECCAS). In addition, there are two RECs that are not recognized by the AU: Southern African Customs Union (SACU) and IOC.

15 Index for Risk Management, INFORM, available at http://www.inform-index.org/

Table 1.2: Participating Countries in the Assessment

Country	Reason for Selection		Regional Membership				
	HDI	Risk Class	EAC	COMESA	IGAD	IOC	SADC
Ethiopia	Low	High	X	X	X		
Kenya	Medium	High	X	X	X		
Malawi	Low	Medium		X			X
Madagascar	Low	Very high		X		X	X
Mozambique	Low	High		X			X
Zambia	Medium	Medium		X			X
Zimbabwe	Low	Medium		X			X

For this purpose, the following activities were undertaken:

- Map the EWS methods and assess their suitability and the extent to which the technical skills and capacity and operating models of regional and national organizations address user needs and adverse weather (El Niño) preparedness.
- Evaluate the efficiency and effectiveness of existing EWSs in terms of grain markets, cross-border trade, commodity price monitoring, and seasonal-scale climate events.
- Evaluate EWS policies and their alignment to meeting the needs of various users.
- Evaluate the cost-effectiveness and sustainability of EWSs in the two sub-regions.

The remaining of the report is structured into four major thematic chapters:

- Chapter Two maps out the EWS methods, the technical skills and capacity for weather and seasonal forecasting, weather observation, crop forecasting, vulnerability assessments, and grain, market, price, and commodity monitoring at the national and regional levels. The chapter assesses the suitability, effectiveness, and efficiency, as well as the strengths and weaknesses and sustainability of these methods in addressing the user needs and their importance in informing preparedness and response.

- Chapter Three evaluates the performance of EWSs in meeting users' needs using the elements of the people-centered framework (Figure 1.6), namely the production of risk information, risk monitoring and warning service, early warning (EW) communication and dissemination, response capability, and EW governance at both the national and regional levels. This includes the assessment of the ability and capacity of the national meteorological and hydrological services (NMHSs), IGAD Climate Prediction and Applications Center (ICPAC), the SADC Climate Services Centre (CSC), the involvement of the private sector, and resource mobilization to ensure the sustainability of EW programs.

- Chapter Four discusses the rationale for investing in food security EWSs and draws some examples of such investment from World Bank projects. Cost-effectiveness approaches and operating models and public-private partnerships (PPPs) are explored for future guidance that informs the food security EWSs in ESA.

- Chapter Five provides selected best practices drawn from within and outside the region. The highlights include the potential role of the private sector in providing climate information services; the ASEAN Food Security Information System (AFSIS); the application of climate and vulnerability information in local planning, which also provides opportunities to integrate indigenous EW information; and the use of climate information forums to help improve the quality of EW information and services. The chapter concludes by providing recommendations to guide future policy approaches and investments in food security EWS at both the national and regional levels in ESA.

CHAPTER TWO: EARLY WARNING METHODS, TECHNICAL SKILLS, AND CAPACITY

2.1 Introduction

Regional and national food security EWS in ESA are supported by a diversity of internationally recognized methodologies (Table 2.1). These methodologies and approaches are generally consistent with the Global Information and Early Warning System on Food and Agriculture (GIEWS) of the Food and Agriculture Organization of the United Nations (FAO) and Humanitarian Early Warning Service (HEWS) developed by the World Food Programme (WFP). The FAO-GIEWS, developed in the 1970s following the world food crisis, provides information on countries facing food insecurity through monthly briefing reports on crop and food prospects, including drought information, together with an interactive map of countries in crisis. The questions addressed include:

- What EW methods are used to assess the risk to food insecurity?
- Are technical skills and capacities adequate and suitable to address user needs as well as the potential to reduce the adverse impact of weather-related hazards?
- To what extent are the EW methods for grain markets, commodity price, and cross-border trade effective and efficient?
- Are the methods cost-effective and sustainable?

In response to these questions, the common EW methods in the ESA countries can be divided into two broad categories. First are those related to understanding the nature of the hazard, such as in-situ observation system for weather and climate data, hydrological data (runoff data), and topological data (for example, elevation database to link runoff forecast with flood extension). This data is obtained from two main sources: weather stations and weather satellites. Usually owned and run by the NMHSs, weather stations record a range of physical measurements of the environment and produce accurate, fine-scale data that are useful for informing and calibrating weather prediction models. Most datasets are generated by weather satellites, providing nowcasting[16] information on rain, lightning, temperature, and wind and are freely available to the NMHSs on online platforms such as SAT2420. Other data sources include methods focused on vulnerabilities that incorporate socioeconomic information such as population density, poverty maps, access to markets, and commodity prices.

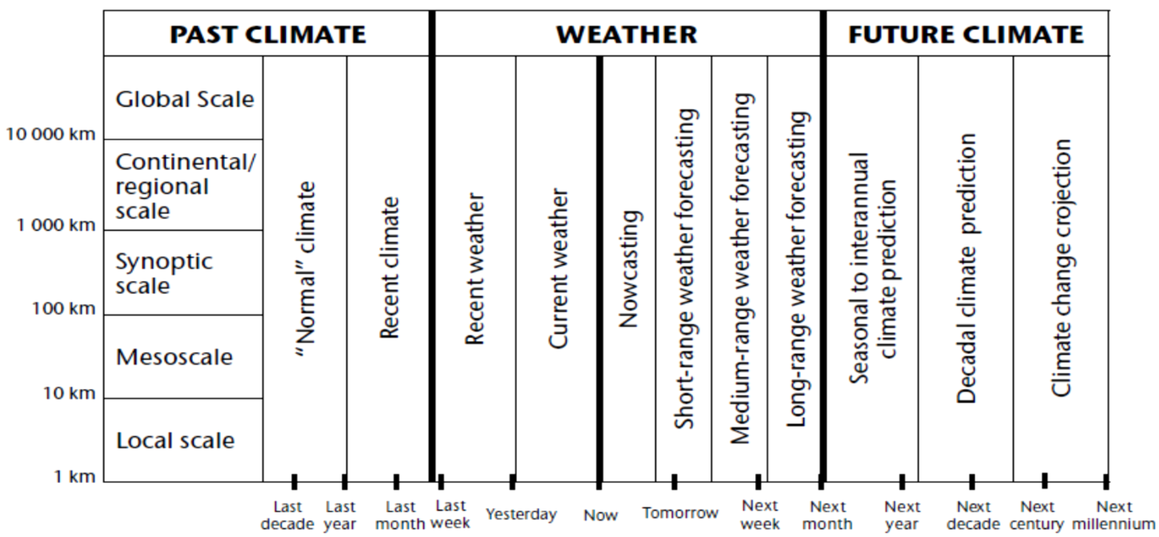
Relevant datasets are usually obtained using generally-accepted methodologies from the social sciences for assessing targeted populations' vulnerability and resilience to natural hazards. Altogether, these hazard and vulnerability assessment methods constitute the first step in the design of an effective food security information and EW system.

[16] **'Nowcasting'** is the detailed description of the current weather along with forecasts obtained by extrapolation for 0 to 6 hours ahead (WMO 1992).

2.2 Seasonal Climate and Weather Forecasting[17] Methods

Providing information and advice on the past, present, and future state of the atmosphere is a central role of the NMHSs, supported by global, and regional climate forecasting and prediction centers. This includes information on temperature, rainfall, wind, cloudiness, and other atmospheric variables and their influence on weather- and climate-sensitive activities and communities. The physical phenomena responsible for the weather and climate conditions are manifested at particular spatial and temporal scales (Figure 2.1), which have important implications on observability, predictability, and service design. The Global Data Processing and Forecasting System (GDPFS) of the World Meteorological Organization (WMO) supports the NMHSs and the regional climate centers mainly through global numerical weather prediction (Box 2.1). The GDPFS prepares and makes available meteorological analyses and forecasting products, which are generated at a few specialized centers (e.g. Pretoria, Melbourne, Moscow, and Washington, DC). With the computing power and technical staff to run these models, in many centers, the models now run at such high spatial resolution (better than 15 km horizontal resolution) that they can be used directly, or downscaled, by the NMHSs in their own forecast production systems.

Figure 2.1: Characteristic Spatial Scales of Weather Phenomena



[17] A **'forecast'** is a statement of expected meteorological (or hydrological) conditions for a specific period and for a specific area or portion of air space (WMO 1992).

Box 2.1: Technical Insight: Functions of the GDPFS

The real-time functions of the GDPFS include

Preprocessing of data (such as retrieval, quality control, decoding, and sorting of data stored in a database for use in preparing output products);

Preparing analyses of the three-dimensional structure of the atmosphere with up-to-global coverage;

Preparing forecast products (fields of basic and derived atmospheric parameters) with up-to-global coverage;

Preparing ensemble prediction system products;

Preparing specialized products (such as limited-area very fine mesh short-, medium-, extended-, and long-range forecasts and tailored products for marine, aviation, environmental quality monitoring, and other purposes);

Monitoring observational data quality; and

Postprocessing numerical weather prediction data using workstation and personal computer-based systems to produce tailored value-added products and to generate weather and climate forecasts directly from model output.

The non-real-time functions of the GDPFS include

Preparing special products for climate-related diagnosis (that is, 10-day or 30-day means, summaries, frequencies, and anomalies) on a global or regional scale;

Comparing analysis and forecast products; monitoring observational data quality; and verifying the accuracy of prepared forecast fields, diagnostic studies, and numerical weather prediction model development;

Storing long-term Global Observing System (GOS) data and GDPFS products, as well as verifying results for operational and research use;

Maintaining a continuously updated catalogue of data and products stored in the system;

Exchanging ad hoc information through distributed databases among GDPFS centers; and

Conducting workshops and seminars on the preparation and use of GDPFS output products.

Source: Rogers and Tsirkunov (2013, 38).

Seasonal forecasting is well developed in ESA. The Greater Horn of Africa Climate Outlook Forum (GHACOF) in east Africa and the Southern African Regional Climate Outlook Forum (SARCOF) in southern Africa are among the renowned global institutions that provide seasonal climate services and EW information (see annex). GHACOF and SARCOF bring together representatives of national and regional meteorological services and users to construct a consensus forecast for the region each year. This involves expressing rainfall occurrence for the coming season as probabilities of below normal, normal, and above normal. The positive impact of both GHACOF and SARCOF on food security is recognized, particularly in informing agriculture production, processing, and marketing (Box 2.2). Through the seasonal forecasts, subsistence farmers in Zimbabwe are able to make decisions on the type of crop to plant, put in place some measures in dam management, and also plan for the malaria season. In Mozambique, the national contingency plan for floods, drought, cyclones, and thunderstorms is based on SARCOF, which is downscaled to the national context.

Table 2.1: Common Methods for Generating Risk Information for an EWS

Theme	Purpose	Methods	Indicators	Coverage/Users	Impact	Challenges
Meteorology (drought, floods, thunderstorms, and so on)	Weather and climate forecasting	Weather prediction models, satellite data, and global circulation	Average rainfall, average temperature, and climate forecasts	National and regional levels; commercial and subsistence producers	Inform planting and harvest dates, off-farm activities, and disaster (scenario) preparedness plans	Resource constraints, weak observation network, downscaling forecasts to high resolution, and dissemination language not tailored to users
Hydrology (water)	Hydrological information and information on dam capacities	Collection of river flow and dam levels	Annual rainfall pattern, dam monthly capacity, and water supply	National and regional levels; commercial and subsistence producers	Inform warning on energy production and water management	Resource constraints, weak observation network, and weak transboundary agreements
Pests infestations (for example, locusts and the FAW)	Information on pest infestations surveillance	Crop monitoring and assessment and surveys	Climate forecasts and leaf tissue	National level; commercial and subsistence producers	Informs contingency plans and pesticide stockpiles	Limited information on the FAW, weak institutional capacity, resources constraints, and weak transboundary agreements
Agriculture production (cereal and livestock)	Provides information on crop and livestock estimates and cereal balance sheets	Crop forecasts (planting and preharvest surveys) and postharvest surveys	Crop/livestock production, yields estimates, grain prices, import and export parity prices	National and regional levels; commercial farmers, grain silo owners, millers and processors, and exporters/importers	Update food balance sheets and livestock levels and trigger imports and exports	Human resource and financial constraints, particularly at regional level and focus biased toward crops and less on livestock
Markets (cereal and livestock)	To regularly collect market information for monitoring and decision making	Market surveys and analysis	Commodity/product prices, agriculture input costs, and food price/trade monitoring	National and regional levels	Triggers imports and exports and destocking	No clear communication between farmers' unions, marketing authorities, millers, and traders

Theme	Purpose	Methods	Indicators	Coverage/Users	Impact	Challenges
Vulnerability (social, economic, health, and nutrition; food availability, access, and utilization)	To provide information on vulnerability to food insecurity and a broader range of vulnerabilities	Vulnerability Assessment and Analysis (VAA) and IPC	Agricultural production, climate/weather information, socioeconomic, anthropometry, and market prices data	VAA mostly used in southern Africa while the IPC is common in east Africa; users - national and regional agencies	Triggers interventions to prevent food insecurity and famine (for example, safety net programs and humanitarian aid)	Harmonization of VAA methodology, training on the IPC, and reliance on external resources

Box 2.2: ICPAC Recommends Early Action Following GHACOF's Rainfall Outlook for March–May 2017

According to the March, April, and May (MAM) 2017 rainfall outlook, the average onset of rains over the equatorial sector is predicted for the second week of March and April 2017 while the southern sector is already in its seasonal rains. Several dry spells will be experienced in the season. The mean cessation dates will be in the third and fourth week of May 2017. These could, however, change if tropical cyclones develop along the western Indian Ocean.

The MAM 2017 rainfall forecast has implication for droughts, floods, and other associated hazards such as natural resource based conflicts and disease outbreak for both human and livestock population over the Greater Horn of Africa. The MAM 2017 seasonal forecast reinforces the existing risk and vulnerability that may lead to serious negative impacts if not attended to. The following mitigation measures are, therefore, recommended.

Mitigation measures for Disaster Risk Management (DRM):

Strengthen regional and national coordination mechanisms.
Strengthen mitigation and response interventions.
Strengthen communication and advocacy campaign.

Agriculture and Food Security Sector:

Ensure diversification of livelihoods.
Plant early maturing and drought-tolerant crops.
Maximize crop production during good rains to boost production volumes.
Increase agronomy and establish plantation farms.
Avoid planting crops in flood- and landslide-prone zones.

Water Sector:

Ministries of water or water agencies should carry out work related to closing open river banks/dykes and strengthening weak ones.
Reservoir management authorities are encouraged to carry out effective reservoir management suitable for above-normal inflows.
Ministries of water or water agencies should intensify rainwater harvesting.

For a zone that is forecasted to receive near-normal to below-normal rainfall, it is advisable that

Ministries of water or water agencies intensify rainwater harvesting and identify and maintain strategic borehole for pastoralists.
Reservoir management authorities are encouraged to carry out effective reservoir management suitable for below-normal inflows.
Municipal water management authorities need to take water conservation and demand management actions.
DRM institutions and nongovernmental organizations (NGOs) carry out conflict management in known hot spots in this zone.

Livestock Sector:

Desilting of water pans
Production and storage of fodder
Livestock vaccination
Restoration and reseeding of degraded lands
Awareness campaign
Livestock insurance

Source: ICPAC 2017.

Some of the challenges GHACOF and SARCOF face include:

- Limited capacity to downscale seasonal forecasts to high resolution;
- Seasonal climate forecasts information not packaged according to user needs; and

- Resource constraints.

First, providing forecast information that is specific to particular users' needs, as shown in Box 2.1, helps users to take appropriate decisions and actions. Improvements are still required in the way the climate information is packaged and delivered to rural people or nontechnical people, such as pastoral communities, who tend to rely on their traditional knowledge and systems of weather forecasting than that of the government (see Box 2.2). Thus, there is still a need across most ESA countries to transform the technical information into actionable recommendations that are provided in a timely and a culturally-sensitive manner, to the targeted audiences. Reaching the targeted communities along the "last mile" of an End-to-End EWS shall be the goal of all relevant stakeholders.

Second, while replicating GHACOF and SARCOF seasonal forecasts to national contexts has become institutionalized, there is limited technical capacity to downscaling the seasonal forecasts to local levels to support local decision making. However, even if the climate forecasts are downscaled to a high resolution there is no guarantee that the predictions will be more precise, as the climate forecasts are based on probabilities. Transforming technical information, including making sense of what the probability of the materialization of an event really means shall be factored in in the communications strategy when interacting with particular audiences, including government non-technical authorities, and the members of local communities, who rely on their traditional knowledge to understand and adapt to their environment.

Third, understaffing especially in the CSC to sustain its mandate including SARCOF. The stakeholders' consultation reveals that the CSC needs about 10 staff in administration, computing, data management, climate science and specialized applications, research and development, and generation and dissemination of products.

While the Monitoring for Environment and Security in Africa (MESA) project funded by the European Union (EU) has enhanced access to reliable, timely, and accurate land, marine, and climate data and information in ESA by providing high-speed computers, these would need to be complemented by data centers, with an appropriate data storage capacity. Besides challenges in downscaling climate forecasts to high resolution, most the ESA countries also have limited capacity to merge and formulate weather data into final products, weak observation network density (Table 2.2), lack of equipment to observe convective weather, such as Doppler radars, and weak human resource capacity to support operations.

While adequate instrumentation is one important component for effective monitoring and forecasting, the technical and financial resources needed for Operations & Maintenance are critical for ensuring the sustainability of the investments in hydromet modernization.

Table 2.2: Hydrometeorological Observation Network Density

Country	Technical Capacity	Enabling Policy Environment	Financial Capacity
Ethiopia	1,200 meteorological stations; 2,000–5,000 weather stations; 25 Automatic Weather Stations (AWSs); upper air observation unit; and AWSs at airports	Limited	Limited government funding to cover costs; charging for services is not permitted by law.
Kenya	39 synoptic stations, 14 agrometeorological stations, 72 AWSs; 3 airport weather observation systems; 17 hydrometeorological AWSs; about 1,000 rainfall stations; 1 upper air station; and 1 global atmospheric watch	Mandate of Kenya Meteorological Department (KMD) revised 2007 and enabled	There is limited funding to cover costs; charging for services is required by law.
Madagascar	19 active stations operated by Directorate-General for Meteorology (DGM) and 4 stations operated by the Agency for Arial Navigation Safety in Africa and Madagascar (ASECNA);[18] 250 more technicians required	Decree No. 2002-803 of August 7, 2002, provides for the organization of the Ministry of Transport and Meteorology.	Limited government funding to meet human resources, equipment, and transport expenses.
Malawi	12 out of 28 districts need weather stations; 21 main meteorological stations are spread across the remaining 16 districts; 63 AWSs	The enabling environment has limited integration of meteorology in national development plans.	Limited government funding
Mozambique	90 stations and needs 150 more stations; has 2 radars but not functioning effectively; needs 7 radars; 300 hydrometeorological networks need upgrading to telemetric; lack of agrometeorological professionals	Regulation No. 6 of 2010 enables the Institute of Meteorological Services to implement cost recovery measures.	Limited government funding; charging for services, for example, aviation and private companies; lack of enforcement on timely payments
Tanzania	26 operational surface synoptic stations; 5 AWSs; 16 operational agrometeorological stations; 60 operational meteorological stations; 500 operational weather stations; 1 upper air station; limited professional staff	There is a Five-Year Plan for the enhancement of meteorological services for sustainable, socioeconomic development in Tanzania.	Funding is primarily provided by the government, but the NMHS does derive nominal income from the aviation sector.
Zambia	Zambia has a network of 108 weather stations (40 manual and 68 automatic). These weather stations are concentrated in 45 out of 107 districts; lack of professional staff	National Meteorology Policy (2013) and the Meteorological Bill (2015) allow sustainability of the NMHS through cost recovery on some selected products and services.	The total budget of ZMD is ~US$5,000, with less than 10 percent of this funding derived from NGOs.
Zimbabwe	65 meteorological stations out of 150 required; 2 radars out of 4; >2,300 rain gauges needed	The Met Services Act 8 of 2003 enables the provision of public services and cost recovery on some products	The Met Services Department has limited government funding.

The majority of countries in ESA are operating far below the WMO's recommended minimum density of weather and hydro observation stations shown on Table 2.3.

[18] ASECNA is an air traffic control agency based in Dakar, Senegal. It operates in the following 17 African countries: Benin, Burkina Faso, Cameroon, Central African Republic, Comoros, Côte d'Ivoire, Gabon, Guinea-Bissau, Equatorial Guinea, Madagascar, Mali, Mauritania, Niger, Republic of Congo, Senegal, Chad, and Togo.

Table 2.3: WMO-recommended Minimum Densities of Stations (Area in km^2 per Station)

Physiographic unit	Precipitation		Evaporation	Streamflow	Sediments	Water quality
	Non-recording	Recording				
Coastal	900	9 000	50 000	2 750	18 300	55 000
Mountains	250	2 500	50 000	1 000	6 700	20 000
Interior plains	575	5 750	5 000	1 875	12 500	37 500
Hilly/undulating	575	5 750	50 000	1 875	12 500	47 500
Small islands	25	250	50 000	300	2 000	6 000
Urban areas	–	10–20	–	–	–	–
Polar/arid	10 000	100 000	100 000	20 000	200 000	200 000

Source: WMO 2012b.

The need to expand the observational networks has increased the demand and preference for AWSs and telemetric gauging stations in the ESA countries. However, most of the NMHS' staff consulted as part of this study reiterated their concerns regard to existing technical and human capacity within their organizations, particularly the need of additional training, as well as of taking into consideration the advantages and disadvantages of using AWSs in low capacity environments (see Table 2.4).

Table 2.4: Advantages and Disadvantages of AWSs

Advantages	Disadvantages
Standardization of observations, both in time and quality Greater reliability - real-time continuous measuring of parameters on a 24/7 basis Improved accuracy (eliminates reading errors and subjectivity) Collection of data in a greater volume, for example, one-minute or five-minute data as opposed to hourly or once per day Automatic adjustment of sampling intervals of different parameters in response to changing weather events Automatic quality control/quality assurance during collection and reporting stages, including automatic alerts to users and maintenance personnel when errors are detected Automatic message generation and transmission, including alerts when critical thresholds are crossed Automatic data archiving Access to data, both real-time and archived, locally or remotely Collection of data in remote, harsh, or dangerous climates	There is a high initial cost of instrumentation and associated equipment and then ongoing costs of operation, such as for maintenance, electrical power, communications, security, and so on. It is not possible to observe all desirable parameters automatically; at key locations, it may be necessary to augment automatic observations with a human observer to obtain information such as cloud coverage and cloud types. If solar panels are used to power a station, this may limit the amount and type of instrumentation, local computing, and telecommunication equipment that can be used. Final quality control is best carried out by a staff of trained operators working on a 24/7 basis. The high volume of data generated requires the development of a data archival system that can be costly and will require periodic forward migration as software changes. Routine preventive and as-required corrective maintenance, together with periodic sensor calibrations, requires a staff of trained maintenance technicians.

Source: World Bank 2015, 20–21.

The Trans-African Hydro-Meteorological Observatory (TAHMO) project provides an opportunity to improve sub-Saharan Africa's capacity for hydrometeorological monitoring. In particular, the TAHMO project aims to build a dense network of hydrometeorological monitoring stations—one every 30 km—in sub-Saharan Africa, by installing 20,000 stations in school grounds. TAHMO is currently collaborating with the Kenya Meteorological Service (KMS) to develop a network of AWSs in schools in Kenya. To promote the sustainability of the project, the use and maintenance of the weather stations will be integrated into the educational curriculum. These objectives align with the mission of KMS to:

- Facilitate accessible meteorological information and services; and
- Infuse scientific knowledge to foster socioeconomic growth and development.

For these climate and weather forecasting methods to deliver timely, accurate, and reliable warnings, there is a need to invest in:

- Strengthening national capacity to downscale seasonal forecasts beyond national levels to the local levels due to limited equipment and technical capacity;
- Developing capacity to ensure the EWS products are packaged according to user needs;
- Strengthening data collection systems and network coverage of the hydrometeorological observation stations; and
- Strengthening data sharing arrangements as sectors still work in silos.

It is worth noticing that while TAHMO has a great potential for making a substantial contribution to ongoing efforts for improving hydromet modernization across regions that are confronted with inadequate coverage of monitoring stations, there are also potential risks to the entire hydromet modernization enterprise at the national levels. Particularly, there is the risk that, in the mid- and long-terms, TAHMO and other similarly well-intentioned hydromet instrumentation efforts, financed by non-government sources, could become another disincentive to the national governments for committing to provide adequate support to their own NMHS. Thus, an unintended consequence of such initiatives could potentially result in less government support, reflected in inadequate budget allocation, to their own specialized agencies. This situation, would in turn exacerbate the vicious cycle of underperforming NMHSs due to lack of adequate funding that leads to even less government support; compelling governments to rely more on non-government sources for its hydromet information needs to support decision-making processes. In addition, the proliferation of monitoring weather stations does not necessarily contribute towards ensuring their compatibility with national and international monitoring efforts (i.e. may not be compatible with WMO's standards and procedures), which could undermine ongoing efforts for improving, regional weather and climate monitoring and forecasting capabilities.

2.3 Crop Forecasting and Monitoring Methods

In most ESA countries, crop production estimates are well established in agriculture ministries and supported by the FAO's GIEWS, where countries can access various tools and support (Box 2.3). However, delays in regular crop production forecast[19] updates render them less useful as an EWS tool. Ideally, observations and measurements of crops (on parameters including area planted, percentage of damage from pests, and weeds infestation) should be made throughout the crop-growing season on a monthly basis.

[19] Crop production forecasts fall into three categories: soon after planting (early forecasts), during the growing season (mid-season forecasts), and some weeks before harvesting (final forecasts).

Box 2.3 Technical Insights of GIEWS

The FAO's GIEWS provides information on countries facing food insecurity through various tools, including the following:

Crop Prospects and Food Situation. This is published four times a year by the Trade and Markets Division of the FAO under GIEWS and focuses on developments affecting the food situation of developing countries and in particular the Low-Income Food-Deficit Countries. The report provides a review of the food situation by geographic region, a section dedicated to the Low-Income Food-Deficit Countries and a list of countries requiring external assistance for food. It also includes a global cereal supply and demand overview to complement the biannual analysis in the Food Outlook publication.

Food Outlook. This is a biannual publication (May/June and November/December) focusing on developments affecting global food and feed markets. It provides comprehensive assessments and forecasts on a commodity-by-commodity basis and maintains a close synergy with Crop Prospects and Food Situation.

The Food Price Monitoring and Analysis (FPMA). Since 2009 when the FPMA tool went online, the database includes over 1,400 monthly domestic retail and/or wholesale price series of major foods consumed in 94 countries and weekly/monthly prices for 85 internationally traded foods. The FPMA tool provides easy access to the data, allowing users to quickly browse and analyze trends of single price series; create comparisons among countries/markets/commodities; and download charts, data, and basic statistics such as maximum and minimum levels, averages, percentage changes, and standard deviations over different periods.

Special Alerts. These short reports describe an alarming food security situation that is developing in countries or subregions. They also alert the international community on measures to be taken.

Special Reports. These short reports describe the food supply and agricultural situation in countries or subregions experiencing particular food supply difficulties. They also alert the international community on measures to be taken. Special Reports are often the result of Crop and Food Security Assessment Missions (CFSAMs) or rapid evaluation missions.

Country Briefs. These provide up-to-date information on the food security situation of monitored countries, including information on the current agricultural season and the harvest prospects for the main staple food crops and livestock situation. In addition, the briefs provide estimates and forecasts of cereal production and imports together with food price and policy developments. Other topical information may be included when relevant. The briefs are updated no less than four times per year.

Country Cereal Balance Sheet (CCBS). The CCBS system is a unique database created and continuously kept up-to-date by GIEWS, with data since 1980. It contains annual supply and utilization balances for the main cereals produced and consumed in all countries of the world.

Earth Observation for Crop Monitoring. To support its analysis and supplement ground-based information, GIEWS uses remote sensing data that can provide a valuable insight on water availability and vegetation health during cropping seasons. In addition to rainfall estimates and the Normalized Difference Vegetation Index (NDVI), GIEWS and FAO Climate and Environment Division have developed the Agricultural Stress Index (ASI), a quick-look indicator for early identification of agricultural areas probably affected by dry spells or drought in extreme cases.

Source: FAO 2017.

Some stakeholders who were interviewed attributed the weaknesses in producing timely updates of crop production forecasts to at least three challenges. First, the paper-based data collection systems were deemed inefficient in providing real-time or near-real-time data for effective decision making. While migrating to mobile technology-based systems is gaining momentum across the ESA countries, Internet costs to upload the data to the system are still prohibitive. Second, there are delays in conducting postharvest surveys, for example, in southern Africa, these are conducted around June/July with the report available around August, which in most cases is late for decision making. Third, limited funding for field logistics means there is inadequate follow-up for data quality assurance.

With respect to pest infestations and the FAW there are gaps in surveillance systems, contingency plans, and management approaches (Box 2.4).

Box 2.4: FAW Monitoring, Impact Assessment, and the EWS

FAW monitoring in some countries in Africa appears to be effective, especially where systematic field surveys have been happening. Specific gaps include the following:

Some countries do not yet have monitoring system in place.

Systematic assessment of economic impacts (present and potential) of the FAW is yet to be undertaken, while many countries are planning to do so.

Almost all countries are presently responding to the outbreak, rather than pursuing EW.

Contingency Planning and Awareness Creation about the FAW among Farming Communities

Most of the countries that were affected or at risk by the FAW have put in place contingency plans, through their respective ministries of agriculture/national plant protection organizations, although some of these efforts are more advanced than others. Challenges include the following:

There is lack of financial and human resources to effectively implement the plans.

There is limited knowledge about the FAW control options to guide the farming communities.

There is lack of adequate and effective control options in the local markets.

Contingency plans are not always anchored in the national laws and regulations.

Awareness about contingency plans appears limited to a few institutions in some countries.

There is lack of regional and continental contingency plans to effectively counter transboundary/invasive insect-pests/pathogens.

Development and Dissemination of the FAW Management Options

The FAW management approaches in several countries affected by the pest were weak because

The FAW management approaches were limited to synthetic pesticides (especially organophosphates, synthetic pyrethroids, a few neonicotinoids, and in some cases cocktails of pesticides).

In most countries, the pesticide applications were mainly emergency responses, but not based on any efficacy evaluation (except in a few countries such as Uganda and South Africa).

In some countries, botanical pesticides such as Neem and Tephrosia were tested and were reported to be effective. In most countries, the use of pesticides in terms of the FAW control was not so effective.

As of April 2017, South Africa has fast-tracked registration of 15 synthetic pesticides and 4 biopesticides for FAW control. Some information/observations on the efficacy of cultural control options, such as handpicking (for example, Rwanda), early planting (in many countries), and management of crop residues were also presented. Very few countries have identified indigenous natural enemies against the FAW and have used biopesticides against the FAW. Except South Africa, no other country in Africa has the option of testing Bt maize (MON89034), which was reported as effective against the FAW in the United States.

Source: Stakeholders Consultation Meeting on "Fall Armyworm in Africa: Status and Strategy for Effective Management." April 27–28, 2017; Nairobi, Kenya

Looking ahead, the following actions need consideration:

- An effective EWS should be in place for a smooth and timely flow of information on the FAW outbreak, coupled with predictive modeling based on relevant factors. A scale of early warning (for example, alarm levels) needs to be designed (backed by quality monitoring data), informed with lessons derived from the US, Brazil, and African armyworm and locust control.
- **Early warning/alerts to countries outside Africa:** There is an imminent danger of the FAW moving to north Africa, and outside, including the Middle East, Europe, and Asia, either through the pest migration or trade. It is very important for these high-risk countries/continents to be alerted in time for putting in place proper contingency plans.
- **Impact assessments:** There needs to be an array of cost-effective, clear, and harmonized impact assessment protocols for the FAW outbreak, building on the existing pre- and post-survey and systems. The impact assessments must take into account physical and socioeconomic/livelihood factors, covering the broad spectrum of agro-ecologies and cropping systems Africa embeds.
- However, the FAW EWS information should be conceptualized within the broad food security information system to leverage on the institutional, technical, and financial resources and preclude any risk of fragmentation of efforts.

2.4 Vulnerability and Capacity Assessments

As the conceptualization of food security evolves, new metrics for measuring food security have also evolved. The conceptualization of food security has gone beyond ‘food availability at all times of adequate world food supplies’ and ‘physical and economic access to basic food’ (Sen 1981) to include ‘utilization’ as well as the ability to acquire socially and culturally acceptable foods (Jones et al. 2013, 443). Emerging out of the shifts in food security conceptualization are composite indicators, which are underpinned by sustainable approaches and participatory approaches (Chambers 1996; Scoones 1998). These are approaches which have emerged under vulnerability and capacity assessments and have increasingly gained currency in the ESA countries. The major actors and some of the common tools and approaches used for monitoring vulnerability, including price and commodity, and cross-border trade monitoring are summarized in Table 2.5.

Table 2.5: Actors in ESA Food Security EWS

Name	Organization Setup	Information Format and Frequency
FEWSNET	FEWSNET and network members	Special reports and food security alerts (depending on severity), Food Assistance Outlook (monthly), Price watch (monthly) in ESA
Food Security and Nutrition Working Group (FSNWG)	Group of NGOs, United Nations (UN) agencies, Red Cross/Red Crescent Movement, food security information systems; technically supported by FAO	FSNWG update on central and east Africa (approximately monthly)
IPC	National and regional (at each level multi-agency and national governments and forums). In east/central Africa region, the IPC is supported by the IPC steering committee of the FSNWG.	Maps with current situation and trends (biannual) for Kenya, Somalia, Uganda, and east Africa and special briefs/updates on Uganda (irregular), Somalia (quarterly); for information on east Africa as a region, it supports the FSNWG.
GIEWS	FAO	Crop Prospects and Food Situation (trimestral), special reports (dependent on emerging crisis, often after CFSAMs), Food Outlook (biannual), and Global Food Price Monitor (monthly)
HEWS	Inter-Agency Standing Committee (IASC) and WFP (WFP is responsible for the coordination/management of content.)	Maps on website, specific tools/reports and links to organizations dealing with specific hazards; various website tools related to hazards like locust infestation, flooding, weather, storms, and so on; seasonal and hazards calendar including seasonal calendar with marked food security-related hazards
VAA	Led by the SADC and the SADC member states supported by Regional Inter-Agency Standing Committee (RIASCO) and NGOs	The VAA database provides a regional snapshot of the SADC humanitarian situation, food insecure population by country, regional food balance sheet (RFBS), malnutrition rates, and socioeconomic context and recommends actions.
East African Grain Council (EAGC)	The EAGC is mandated by the EAC to coordinate the private sector and looks at two systems on Market Information System (MIS).	Through the RATIN, the EAGC provides updates on daily price information, monthly cross-border trade, real-time warehouse volumes, food balance sheets, trends and projections of trade, and bids and offers for market access.

Source: (Ververs 2012, 132) and author.

Evidence from the RVAA reports 2012–2016 illustrates that most of the countries in southern Africa conduct National Vulnerability Assessment and Analysis (NVAA) annually (Table 2.6).

Table 2.6: NVAA Reports Consolidated into RVAA (2012–16)

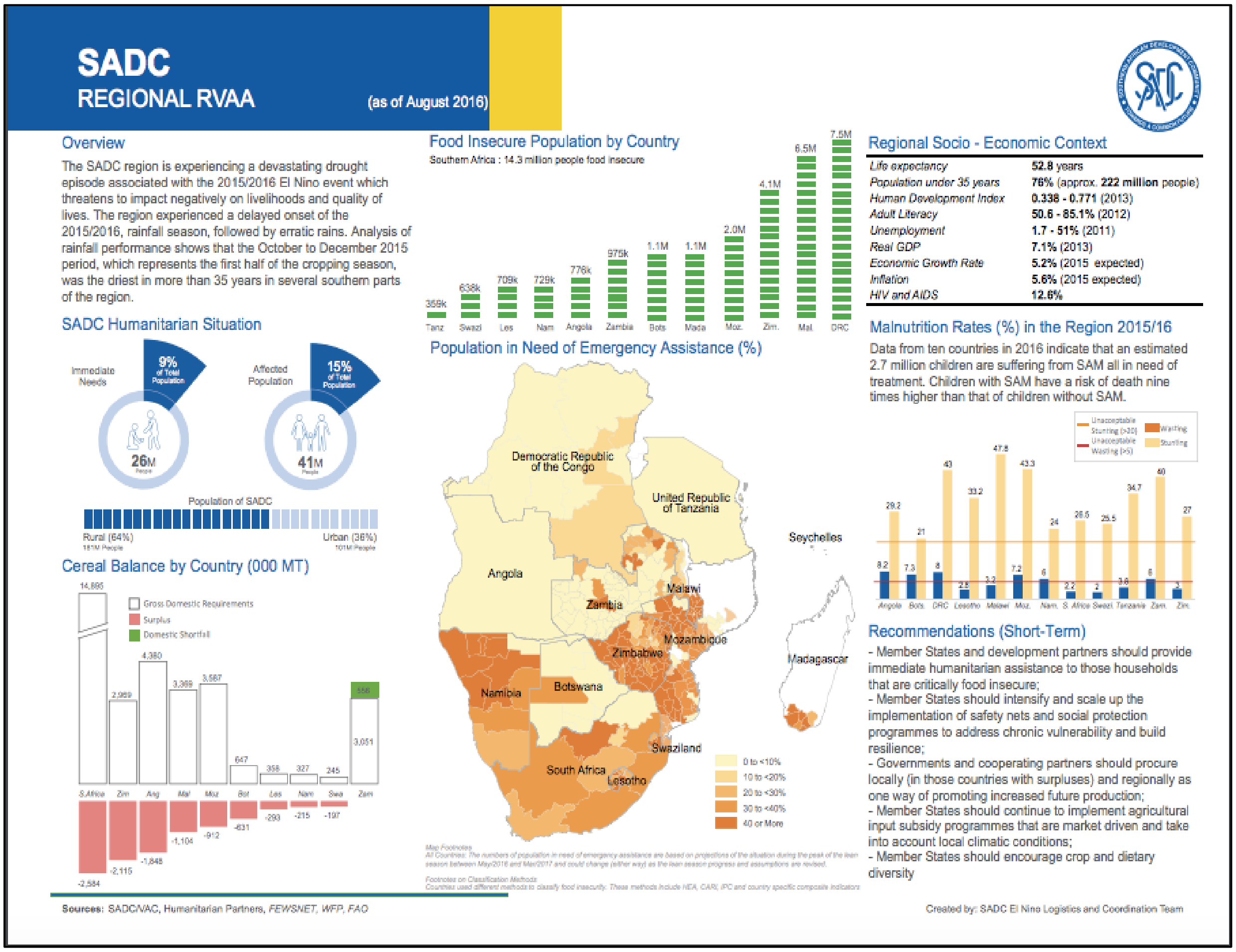
Country	Year				
	2012	2013	2014	2015	2016
Angola	—	X	—	—	X
Botswana	X	X	X	X	X
Democratic Republic of Congo	—	X	X	X	X
Lesotho	X	X	X	X	X
Madagascar	—	—	—	—	X
Malawi	X	X	—	X	X
Mauritius	—	—	—	—	—
Mozambique	X	X	X	X	X
Namibia	X	X	X	X	X
Seychelles	—	—	—	—	—
South Africa	X	—	—	—	X
Swaziland	X	X	X	X	X
Tanzania	X	X	X	X	X
Zambia	X	X	X	X	X
Zimbabwe	X	X	X	X	X
Total	**10**	**11**	**9**	**10**	**13**

Informed by qualitative information derived from participatory techniques such as interviews, focus group discussions and mapping, the VAAs allow for a contextual understanding of food security and livelihood vulnerability in specific settings. In particular, the VAAs delineate geographic patterns of shared livelihoods, groups of households based on wealth and assets, and categorizes livelihood strategies, including coping strategies. The NVAA data are consolidated into a regional VAA database around June each year to provide a regional overview, and a bulletin (Figure 2.2) is issued, which provides a snapshot of the SADC humanitarian situation, food insecure population by country, RFBS, malnutrition rates, socioeconomic context, and recommendations. The success of VAAs hinges on the following:

- The VAAs are multi-sectoral surveys conducted annually around May.
- There are guidelines for the VAA processes.
- The multi-sectoral approach helps build trust across both data producers and users.
- The governments in the SADC own VAA results and officials access them for public use.[20]

[20] In some countries, during the early ages of NVAAs, the results were often delayed, mainly due to political sensitivity around food security. To address the political challenges, the VAC reports present plain facts, with analysis and judgements left to the users in a way that is neutral to avoid contentious issues. These descriptive reports are readily accepted by the governments. However, in terms of the EWS, such VAC reports provide important inputs to the risk knowledge component of such EWSs. However, VAC reports are not intended to be vehicle for providing recommendations on the specific actions to be taken.

Figure 2.2: Good Practice from the SADC RVAA System



Source: SADC 2016b, 40.

The VAA challenges are summarized in Box 2.5.

> **Box 2.5: VAA Challenges**
>
> The VAA reports are produced around June, which is late if the tool has to be effective for the EWS. Although the information is made available to users at the regional and national levels, the data is not made available to stakeholders at the subnational levels and it is not in the language that is understood by communities.
>
> Local people believe that VAAs are not a useful tool because they block them from accessing food aid.
>
> There is a need to harmonize the VAA methodologies or at least to agree on the minimum indicators.
>
> In some countries, the VAA reports do not recommend actions to be considered, suggesting that the report does not trigger action.
>
> In the majority of countries, VAAs rely on funding from partners.

Developed by FAO in Somalia in 2004, and conceptually complementary to the VAAs, almost all IGAD countries, except Ethiopia and Eritrea (Table 2.6), use the IPC to classify food security outcomes (Table 2.7 and Figure 2.3). The advantage of the IPC is that it provides guidelines for data collection and dissemination of information and its results can be compared with other neighboring countries or regions and can identify action triggers.

Table 2.7: Progress in Adopting the IPC Tool in East Africa

Country	Year Introduced	Location of the IPC
Burundi	2008	Ministry of Agriculture and Livestock
Ethiopia	—	—
Eretria	—	—
Djibouti	2011	Ministry of Agriculture
Kenya	2007	National Drought Management Authority, supported by Kenya Food Security Steering Group (KFSSG)
Somalia	2004	The Food Security and Nutrition Analysis Unit (FSNAU) and governments of Somaliland and Puntland
South Sudan	2007	National Bureau of Statistics chaired by the Ministry of Agriculture, Forestry, Cooperatives, and Rural Development
Sudan	2007	Ministry of Agriculture and Irrigation through its Food Security Technical Secretariat
Tanzania	2008	Ministry of Agriculture, Food Security, and Cooperatives
Uganda	2007	Ministry of Agriculture, Animal Industry, and Fisheries

Source: IPC 2017.

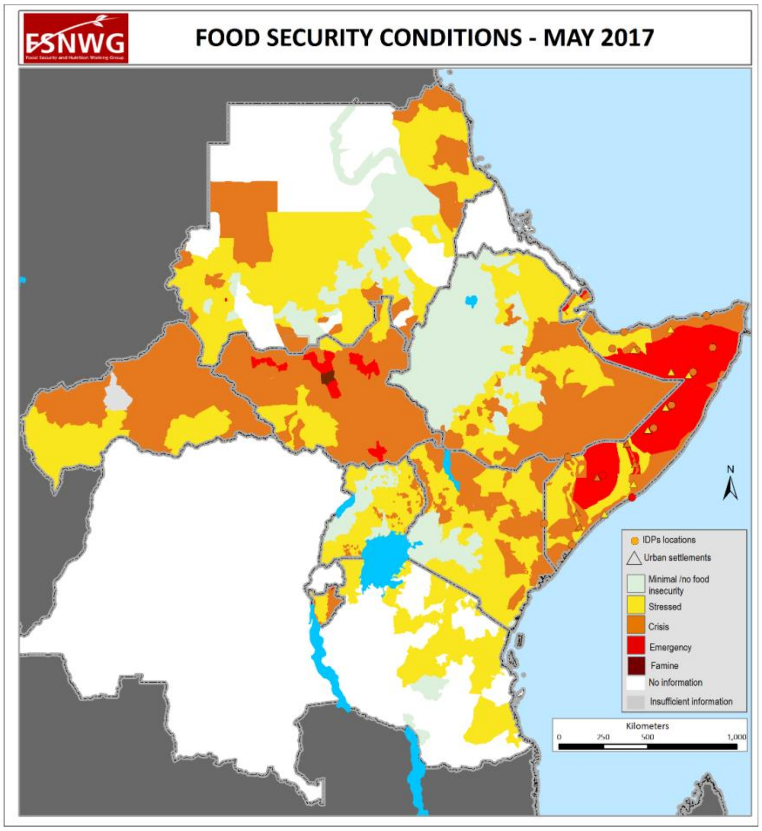
Table 2.8: IPC Phase Descriptions

Phase Name	Phase description			Priority response objective
Phase 1 Minimal	Household (HH) group is able to meet essential food and non-food needs without engaging in atypical, unsustainable strategies to access food and income, including any reliance on humanitarian assistance.			Resilience building and disaster risk reduction.
Phase 2 Stressed	Even with humanitarian assistance, HH group has minimally adequate food consumption but is able to afford some essential non-food expenditures without engaging in irreversible coping strategies.			Disaster risk reduction, protection of livelihoods.
Phase 3 Crisis	Even with humanitarian assistance, HH group has food consumption gaps with high or higher than usual acute malnutrition; OR HH group is marginally able to meet minimum food needs only with accelerated depletion of assets that will lead to food consumption gaps.	Food-insecure people (Phase 3 or higher)	Urgent action required	Protect livelihoods, reduce food consumption gaps and reduce acute malnutrition.
Phase 4 Emergency	Even with humanitarian assistance, HH group has large food consumption gaps resulting in very high levels of acute malnutrition and excess mortality OR HH group has extreme loss of livelihood assets that will lead to large food consumption gaps in the short term.			Save lives and livelihoods.
Phase 5 Famine/ Catastrophe	Even with humanitarian assistance, HH group has an extreme lack of food and/or basic needs even with full employment of coping strategies. Starvation, death and destitution are evident.			Prevent widespread death and total collapse of livelihoods

Source: FAO (2017).

There are, however, some important considerations regarding the way in which the IPC protocols are implemented in different countries, due in part to differences in the manner in which some countries use specific food security outcome indicators while others countries make inferences based on proxies to compensate for data gaps. Another important consideration is the timing of the IPC analyses. Seasonal factors can affect the outcomes of the IPC analysis. While the adoption of the IPC protocols continues to grow, it is yet to be endorsed by several countries as well as regional organizations.

Figure 2.3: IPC Predicts Famine in Somalia (IPC Phase 5)



Caseloads Trends (IPC Phase 3 & above/require humanitarian Assistance)

Country	GHA Food Insecurity Trends: IPC 3-5 (Require Humanitarian Assistance, in Millions)				Main Source & Validity of Current Caseloads
	Sept 2016	Dec 2016	Feb 2017	May 2017	
Djibouti	0.3	0.2	0.2	0.2	IPC November 2016
Ethiopia	9.7	5.6	5.6	7.8	DRMTWG, April 2017
Kenya	1.3	1.3	2.2	2.2	IPC/NDMA, Feb 2017
Somalia	1.1	1.3	2.9	3.2	Joint FSNAU-FEWSNET Somalia Food Security Alert, May 2017
S. Sudan	4.8	4.6	4.9	5.5	IPC May – June 2017 Projection
Sudan	4.4	3.6	3.0	2.8	IPC April 2017 Update
Uganda	0.4	0.4	1.6	1.6	IPC Jan – March 2017
Burundi	1.5	1.5	1.5	2.6	IPC April – May 2017
Tanzania	-	-	1.2	1.2	IPC Feb 2017
Total	23.5	18.5	23.1	27.1	

Source: Compiled from FSNWG reports available from http://www.fao.org/disasterriskreduction/east-central-africa/fsnwg/en/.

2.5 Methods for Grain, Market, Cross-border, Price, and Commodity Monitoring

Grain, market, cross-border, and price monitoring are among the key components of an effective food security EWS. Monitoring these components helps to track food security conditions and trends at the regional, national, subnational, community, and household levels. If the monitoring finds unusual patterns or behaviors, this information becomes useful in forecasting food security conditions and make recommendations on the expected type of responses.

2.5.1 Production Monitoring: The National Food Balance Sheet

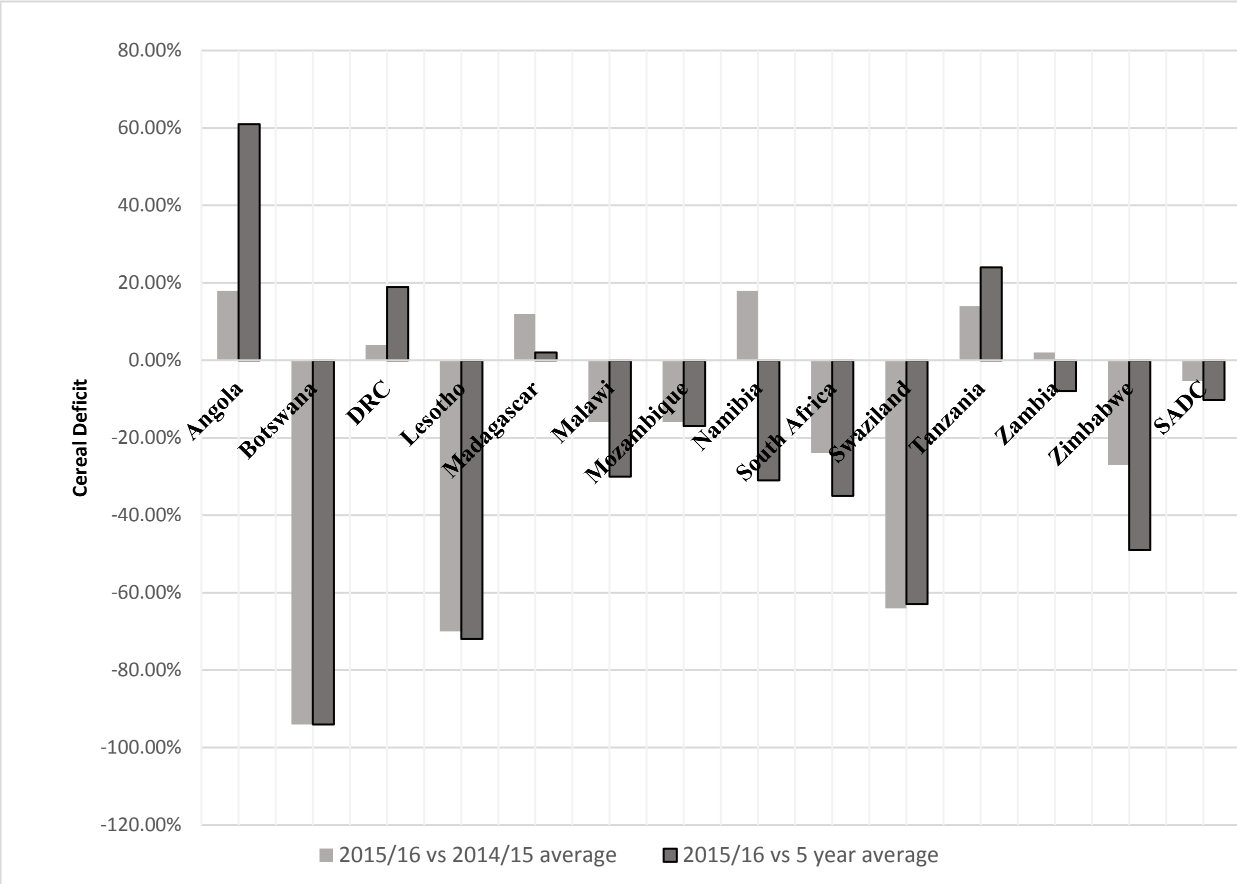
The National Food Balance Sheet (NFBS) is a globally tried and tested method and primarily used to present a comprehensive picture of the pattern of a country's food supply during a specified reference period. In particular, the NFBS estimates the total domestic foodstuffs production added to the total quantity imported and adjusted to any change in stocks that may have occurred since the beginning of the reference period. This information is compared with the average national demand for consumption and other uses such as feeding livestock and seed as well as losses during storage and transportation (FAO 2001; Jacobs and Sumner 2002). Consequently, the NFBS is one of the common tools used for food security EWSs across the ESA countries (Tefft, et al., 2006). In southern Africa, the NFBSs are well established, institutionalized within government structures, and updated annually. Table 2.9 and Figure 2.4 show the food production deficits for 13 SADC countries between 2011 and 2016, which informed the SADC's appeal for humanitarian aid in June 2016 (SADC 2016a), following the El Niño-induced drought.

Table 2.9: The SADC Regional Cereal Production (Tonnes) 2010-216

Country	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16	2015/16 vs 2014/15 percentage	2015/16 vs 5 yr Avg percentage
Angola	1,367,429	505,795	1,672,184	1,820,348	2,016,566	2,374,208	18	61
Botswana	61,796	52,607	33,756	260,000	90,317	5,610	−94	−94
Congo, Dem. Rep.	2,537,145	2,602,074	2,583,228	2,797,317	3,127,252	3,257,829	4	19
Lesotho	103,170	58,162	120,094	103,526	89,035	26,747	−70	−72
Madagascar	4,729,495	4,998,597	3,989,872	4,344,037	4,051,671	4,530,365	12	2
Malawi	3,895,181	3,623,924	3,639,866	3,978,123	3,001,730	2,531,703	−16	−30
Mozambique	2,934,591	3,715,000	2,371,190	2,509,788	2,845,000	2,388,806	−16	−17
Namibia	127,600	168,500	81,500	131,900	67,800	80,000	18	−31
South Africa	13,084,335	14,764,619	14,502,889	16,940,000	12,206,315	9,323,455	−24	−35
Swaziland	88,502	76,091	81,934	118,871	93,653	33,860	−64	−63
Tanzania	7,033,498	7,435,957	7,806,580	9,828,540	8,918,999	10,139,108	14	24
Zambia	3,367,182	3,195,355	2,890,045	3,643,877	2,898,054	2,943,807	2	−8
Zimbabwe	1,648,404	1,129,845	943,620	1,718,630	868,017	637,843	−27	−49
SADC	**41,197,438**	**42,425,504**	**40,840,506**	**48,321,075**	**40,398,477**	**38,273,341**	**−5.3**	**−10.2**

Source: SADC VAA Report 2016.

Figure 2.4: Cereal Deficits in the SADC, 2011–2016



Source: SADC VAA Report 2016.

Similarly, in east Africa, the EAC identifies the RFBS as a critical tool for enhancing intra-regional trade because it provides policy makers with the data they need to make informed decisions on policies that affect regional food security. Supported by the East Africa Trade Hub and the five EAC countries (Burundi, Rwanda, Tanzania, Kenya, and Uganda), and through the ministries of agriculture, the National Food Balance Sheet Committees (NFBSCs) feed the data onto the RFBS Portal.

The EAGC is mandated by the EAC to coordinate the private sector and looks at two systems on MIS:

- The RATIN that monitors prices and volumes
- The EAGC RFBS that monitors actual food stock. Currently, the EAGC monitors 14 borders regionally and 41 markets focusing on six staples: wheat, maize, sorghum, beans, rice, and green grams.

Market Access Subgroup (MAS) that includes FEWSNET, EAGC, WFP, and FAO contributes data from the informal arrangement and consolidates into one quarterly report for monitoring food security. This is one of the tools used by relief agencies for humanitarian assistance.

Notwithstanding their invaluable contribution to the EWSs, the NFBSs face numerous challenges including

- Delays in regular crop production forecasts (as stated) and
- Lack of clear guidelines for agencies involved in developing the NFBSs.

The Zambia Disaster Management and Mitigation Unit (DMMU), provides standard operating procedures (SOPs) on the steps that the responsible sectors need to take to produce the NFBS (Table 2.10).

Table 2.10: Good Practice on Processes Leading to the NFBS Production in Zambia

Activity	Due Date and Responsible Body
Seasonal rainfall forecast	By end of September, forecasts are generated by Zambia Meteorological Department (ZMD) and submitted to the DMMU and other relevant departments and authorities.
Hydrological conditions	By end of every month, information on hydrological conditions is generated and submitted by the Department of Water Affairs and submitted to the DMMU and other relevant departments and authorities.
Preliminary crop forecast	By January 31 each year, the Ministry Responsible for Agriculture and Livestock (National Early Warning Unit), the agency responsible for national statistics, and the ZMD will generate the preliminary crop forecast report and submit to the DMMU and other relevant departments and authorities.
Final crop forecast	By April 30 each year, the National Early Warning Unit in the Ministry Responsible for Agriculture and Livestock, the agency responsible for national statistics, and the ZMD will generate the final crop forecast report and submit to the DMMU and other relevant departments and authorities.
NFBS	The NFBS will be published by May 15 each year.
Comprehensive needs assessment	By June 15 each year, the DMMU in collaboration with other multi-sectoral agencies will publish a report on the impact of drought and vulnerabilities.

Source: DMMU 2015.

2.5.2 Markets and Price Monitoring for Food Security

Markets are critical for informing food security early warning analysis because they help shed light on two of the three elements of food security: availability and access. Markets will highlight signs of deterioration or improvement in food availability and access such as production shortfalls, non-seasonal increases in the prices of food and inputs, falling agricultural output prices, distress sales of livestock, and uncharacteristically early or large migration of people in search of causal employment.

Most of the ESA countries have established marketing and price monitoring systems, most of them being housed in their Ministry of Agriculture's economics, marketing, or agribusiness departments. In addition to these departments, some countries, like Botswana, Kenya, Malawi, Zimbabwe, and Zambia, have agriculture-marketing authorities, boards, centers, or corporations. Table 2.11 shows market analysis for Taita Taveta County in Kenya, which helps determine when prices are prohibitively high for some households and/or when particular events or conditions prevent participants of market networks from responding by releasing stocks or moving commodities from one location to another. Labor market conditions that result in low wages or insufficient labor opportunities also affect household food access (FEWSNET 2009).

Table 2.11: Market Performance for February 2017 for Taita Taveta County, Kenya

<table>
<tr><td>Cattle Prices
The average price of a three-year-old bull from 210 sampled households decreased to K Sh 16,800 from K Sh 17,000 in the previous month.
The drop in price could be attributed to deteriorating cattle body condition.
Compared to the long term mean, the average price is the same.
Livelihood variations were notable; in the horticulture/dairy livelihood zone, cattle prices range between K Sh 25,000 to K Sh 40,000, while in hotspot areas, mainly in food crops/livestock livelihood zone, prices ranged between K Sh 8,000 to K Sh 10,000.</td><td>Goat Prices
The average price of a three-year-old goat from 210 sampled households remained at K Sh 3,800 as in the previous month.
The low price could be attributed to fair goat body condition.
Compared to long-term mean, the average price is higher by 6.1 perecnt
No significant variations in prices of goats were observed across livelihood zones.</td></tr>
<tr><td>Maize
Compared to the previous month, average price of maize per kg at household level remained at K Sh 41.80.
Lowest prices ranged from K Sh 30 to K Sh 35 in the mixed farming: irrigated cropping/livestock livelihood zone, areas of Challa and Eldoro in Taveta Sub-county.
Highest price was recorded in mixed farming: food crops/livestock livelihood zone, Mwakajo, Rukanga, and Mwachawaza at K Sh 40.00 to K Sh 45.00 in Voi and Mwatate Sub-counties.
Compared to the long-term mean the price is higher by 4.2 percent</td><td>Beans
Compared to the previous month, average price of beans per kg at household level remained at K Sh 91.80.
Lowest prices were recorded in mixed farming: irrigated cropping/livestock/food crops livelihood zone, Challa at K Sh 60 to K Sh 70 due to incoming beans from the Republic of Tanzania, while high prices were recorded in mixed farming: food crops/livestock livelihood zone, Mwakajo, Mwachawaza, and Rukanga at K Sh 90 to K Sh 110.
Compared to the long-term mean bean prices are almost equal.</td></tr>
<tr><td>Income
Analyzed income from 210 sampled households show that sale of charcoal, casual labor, and remittances rose by 3 percent, 3 percent, and 1percent respectively.
Petty trading dropped by 4 percent while formal employment, sale of livestock products, and sale of crops decreased by 1 percent each compared to the previous month.
Most households are now depending on charcoal burning and remittances.</td><td>Terms of trade (ToT)
ToT remained favorable from sampled households in the month under review.
The sale of 1 goat at K Sh 3,800 resulted in the purchase of 90.9 kg of maize at K Sh 41.80 per kg. This is a drop compared to 95.12 kg posted in the previous month.
Though ToT remained the same as in the previous month, the trend is decreasing due to increasing prices of maize due to poor harvest and decreasing prices of goat emanating from deteriorating body condition.</td></tr>
</table>

Source: Compiled from Kenya National Drought Management Authority.

Although in most ESA countries, commodity price monitoring is conducted on a monthly and weekly basis, in some countries there are no specific recommendations to help users take action. The market report in Table 2.11 provides objective information that helps end users decide on the action to be taken. In contrast, while the example from Zimbabwe provides a list of prices for the week, it is not analytic and does not elicit action. However, providing information without analysis and recommendation is a deliberate process because this allows users to make their own analysis and decisions. In this way, the reports are neutral to avoid contentious political issues.

There are also institutional challenges in commodity price monitoring that, according to study participants, tend to be more problematic than resource constraints. The liberalized nature of cereals marketing has brought a paucity of players in market and commodity price monitoring. Although in the sampled ESA countries there are strategic grain reserves (SGRs), with some level of government control on its use, there is little information exchange between the players. In Zambia, there are at least five sets of players in commodity and price monitoring data. The government collects data through the Agricultural Marketing Information Centre (AMIC) and shares with the Food Reserve Agency and the National Early Warning Unit while the Zambia National Farmers' Union and FEWSNET each collect their own data. The same applies in Zimbabwe where the Agriculture Marketing Authority shares data with the Grain Marketing Board (GMB) while the Zimbabwe Farmers' Union (ZFU) and FEWSNET each produce their own data. Although the data is collected for different purposes, for example, the government and FEWSNET use the data for food security monitoring while the farmers tend to focus on marketing their commodities, there is no real information exchange between the government departments and the stakeholders.

In relation to the SGR, its primary function is to help a country cope with food emergencies and stabilize grain prices sometimes (Table 2.12). The reserves can be in physical grain or financial reserves, for example, in addition to the buffer stock of 500,000 tonnes in Zimbabwe's GMB, there is a cash reserve equivalent of 436,000 tonnes. The physical stock aims at meeting Zimbabwe's food shortfalls for three months, and assuming the financial reserve equivalent is available to import the grain, then grain will be available for another three months. Often times, countries do not have adequate financial reserves to import food.

Properly managed SGRs contribute to price stabilization. SGRs are replenished during times of normal or above-normal production to be used when markets are not able to meet the demand, increasing the risk of vulnerable households and communities to fall into a food insecurity situation. Under such conditions, tapping into the SGRs to meet the demand of struggling populations makes a lot of sense, and it is part of the governments' tools for addressing its contingent liabilities. Governments have the authority and the responsibility for intervening, even by distorting market prices, when there is an urgent need for protecting vulnerable populations.

Governments, communities and/ or farmers are the main targeted audience in the development of EWS information. To meet the expectations of each user group, it is best practice to have analysts with in-depth knowledge analyze the data and present the minimum of information needed, concisely, with narrative and in context. Additionally, there is needed to be clear on the level of confidence in the projections being made.

Collecting, compiling and presenting data in tables and graphs isn't enough. Data needs to be analyzed, interpreted, and placed in context, with appropriate perspective provided. Knowing who your audiences are, and what are their perspectives and needs is essential to designing information products that will be useful and used. Users should not be overwhelmed with data – the analyst should select the minimum set of data required to explain and substantiate conclusions. Perspective should be provided that helps the user to understand whether the situation and trends observed are usual or represent anomalies. In this case, if the target audience is the farmers, they need weather forecasts that are precise with no technical language, interpreted in local languages and presented in an easy to understand form, e.g. formulate scripts to be streamed as videos on Television, and run on FM Radios.

Policy and decision-makers (Government) need to understand why specific pieces of data are being presented to them, and why they are important. This information should be disaggregated geographically and illustrate conditions for populations typically vulnerable to a given disaster risk (Bonnard & Sheahan, 2009). Communities and/or farmers need to understand the extent of the anomalies arising from the situation (in form of warnings or alerts) and the corresponding sufficient coping capacities (responses) visa vie the locally affordable coping options – what ought to be done within their capacities to mitigate the disaster.

Concisely, while it seems self-evident, an EWS that monitors without forecasting; and, provides warnings or alerts without being linked to a well-thought through plan and range of response options, will not meet its objectives. Therefore, it is imperative for the analysts to link early warning to response, link information flows to decision making processes.

Table 2.12: Role of the SGR in Grain and Price Monitoring

	Zimbabwe	Zambia	Kenya	Malawi
Agency	GMB	Food Reserve Agency (FRA)	National Cereal and Produce Board	Agricultural Development and Marketing Corporation (ADMAC)
Functions	Operates as parastatal with a commercial and social role	Operates as a semiautonomous body on commercial and social lines	Parastatal with a commercial and social role	Commercial and social roles
Strategic reserve	936,000 tonnes (500,000 physical stock and 436,000 tonnes, backed by cash reserve of equivalent)	500,000 MT to give at least three months of buffer stock	Stock of up to 8 million bags for food security and facilitates logistics for famine relief food	100,000 MT
Pricing	Premium prices for maize	Premium price for maize	Premium price for maize - among the highest in Africa	Premium price for maize, suggested by government
Price monitoring	Weekly by ZFU, FEWSNET, and Agriculture Marketing Authority	National Farmers' Union, Food Reserve Agency, National Early Warning Unit, and FEWSNET	Kenya National Farmers' Union and FEWSNET	ADMAC, Ministry of Agriculture, FEWSNET, and National Small Holder Farmers Association of Malawi (NASFAM)
Challenges	Getting information from private sector as the GMB is a competitor; it is difficult to get information from the millers	Farmers expect FRA at premium price but stocked maize offloaded at subsidized prices during times of food insecurity	Information not easily accessible from private sector	Prices offered below production costs; challenges in obtaining real-time data due to Internet costs; weak coordination

CHAPTER THREE: PERFORMANCE OF EWSS IN EASTERN AND SOUTHERN AFRICA

3.1 Introduction

The effectiveness of food security EWSs depends on the level of capabilities of national and regional bodies in terms of risk knowledge, monitoring and warning service capacity, dissemination and communication, and response capability. For these elements to produce a positive impact on food security EWSs, coordination of national and regional agencies, appropriate legal frameworks, clear roles and responsibilities, involvement of the private sector, and predictable funding mechanisms are critical. This chapter is guided by five key questions (themes):

- Are systems that are regularly updated and accessible in place at national and regional levels for key hazard and vulnerability identification and analysis, supported by integrated maps for areas and communities that could be affected by natural hazards?
- Does an effective national and regional hazard monitoring and warning service with a sound scientific and technological basis, language, and communication protocols exist?
- Is there an established system for organizational and decision-making processes with a strong warning dissemination and communication chain, with the messages tailored to the specific needs of those at risk?
- To what extent does the EW information inform preparedness and response plans and what measures are in place for public awareness and education?
- Are roles and responsibilities of various public and private sector EW stakeholders clarified and reflected in the national and regional regulatory frameworks, planning, budgetary, coordination, and operational mechanisms?

In response to these questions, this chapter is based on the questionnaire survey that was administered to 46 producers and users of food security EW information in 15 countries[21]. Responses to thematic subjects under each theme were scored based on a hierarchy of perception on a 5-point Likert scale with 1 point awarded to strongly disagree and 5 points awarded to strongly agree. The frequencies of perceptions of the thematic subjects [22]on the 5-point scale were calculated by dividing the number of respondents with a score with the total number of respondents available and expressed as a percentage.

3.2 Performance of EWSs at the National Level

3.2.1 EWSs and Risk Knowledge at the National Level

National risk assessments form the backbone of an effective EWS. Risk assessments require systematic, standardized collection and analysis of data, supported by legal and institutional frameworks that clarify roles and responsibilities for agencies involved in risk assessments, and the affected communities. Table 3.1 shows that risk assessments are regularly conducted in most ESA countries. About 85 percent of the respondents agree that agencies involved in risk assessments are identified and their roles and responsibilities clarified. About 65 percent felt the national standards for risk assessments exist while about 71 percent opined that hazards were

[21] Responses to the questionnaires were further supplemented by consultation with at least 50 stakeholders in 7 countries

[22] Thematic subjects refer to statements used to measure the five key questions.

regularly evaluated. However, 66 percent disagreed that risk assessment results were disaggregated to the social demographics, while the lack of involvement of the private sector and local communities in risk assessment received a score of 61 percent. Most participants (67 percent) also felt that a central database did not exist; yet, such an information system is one of the critical elements of an effective EWS.

Across all studied countries, respondents agreed that responsible agencies have clear roles and responsibility in risk assessments, however, it was only in Rwanda, Djibouti, Sudan and Swaziland where respondents were fully confident that national standards for risk assessment exist. With the exception of Ethiopia (0 percent), Somalia (0 percent) and Zimbabwe (28.5 percent), other respondents confirmed that hazards are regularly analyzed and evaluated; with integrated risk and hazard maps developed as appropriate. Only respondents from Djibouti (100 percent) and Rwanda (100 percent) noted that vulnerability assessment maps conducted annually with disaggregated results. Consultation of affected communities and industries while conducting risk assessment is only sufficiently done in Djibouti (100 percent) and Swaziland (100 percent), however, it is only in Sudan (100 percent) and Kenya (33.3 percent) where Risk assessment results are integrated in local risk management plans. With the exception of Somali (0 percent), respondents in all other countries were confident of the existence of a national central risk assessment database.

Table 3.1: Effectiveness of Risk Assessments at the National Level

Subjects	Frequency, percentage				
	Strongly Agree	Ag ree	Somewhat Disagree	Disa gree	Strongly Disagree
Agencies have clear roles and responsibility in risk assessments	32	53	5	5	5
National standards for risk assessments exist	15	50	20	5	10
Hazards are regularly analyzed and evaluated	24	47	14	10	5
Integrated risk and hazard maps are regularly developed	14	42	10	24	10
Community vulnerability assessments are conducted annually with disaggregated results	10	24	28	28	10
Affected communities and industry are consulted in risk assessments	10	29	19	32	10
Risk assessment results integrated in local risk management plans	0	50	19	19	12
Central database for risk assessments exists	0	33	9	29	29
Average	**13**	**41**	**16**	**19**	**11**

3.2.2 EW Monitoring and Warning Services at the National Level

Credible regional hazard and vulnerability monitoring, in addition to being supported by science and technology, also needs strong regional coordination in order to leverage limited resources and interagency capabilities. Table 3.2 summarizes the responses to the subject on the effectiveness of hazards monitoring and warning services. Hazard monitoring and warning systems at the national level are well established. At least 75 percent of the respondents felt that agencies with a hazard monitoring and warning remit were clearly identified and their roles were clarified in legal and policy frameworks. However, although 75 percent of the responses indicate food security information systems are in place in most countries, the field consultations established that these information systems tend to be fragmented along sector lines, which poses difficulties for users to access information. Even if an information system was established, it was noted that government departments were not accustomed to sharing their data with other departments.

To address data-sharing challenges, respondents suggested the convenience of developing Memoranda of understanding (MoU) between the relevant agencies. Through the establishing MoUs it is possible to specify what types of data, their format, and the frequency in which datasets should be shared. Key Informants (KIs)' opinions were split on their perception of topics regarding hazard monitoring and warning services provided at the national level.

Agency roles and responsibilities in monitoring and issuing warnings are clear and well elaborated in Djibouti (100 percent), Sudan (100 percent) and Swaziland (100 percent); supported with binding agreements for consistency in warning language and communication channels. However, only respondents from Rwanda, Sudan and Swaziland were fully aware of the existence of a national food security system. In Djibouti, Ethiopia, Kenya, Sudan and Rwanda; 100, 50, 60, 100 and 100 percent of the respondents, respectively, noted that EW systems are subjected to regular tests but it only on Kenya (80 percent) and Sudan (100 percent) were verification is done to ascertain if warnings have reached intended recipients. In Kenya, Sudan, Swaziland and Zimbabwe; 100, 50, 100 and 83.3 percent of the respondents, respectively, agreed that Equipment for hazards and vulnerability monitoring is suitable, and personnel trained in O & M. With the exception of Somali and Rwanda, respondents from other countries noted that Hazards and food security data from regional networks, adjacent territories and international sources is accessible. It is only in Djibouti (100 percent), Kenya (80 percent) and Zimbabwe (50 percent) where respondents had confidence that data is received, processed and warnings disseminated in timely, in meaningful formats, in real or near-real time. With the exception of Djibouti and Somali, respondents in other countries noted that data analysis, prediction and warning are based on accepted scientific and technical methodologies.

Table 3.2: Effectiveness of Monitoring and Warning Services at the National Level

Subjects	Frequency, percentage				
	Strongly Agree	Agree	Somewhat Disagree	Disagree	Strongly Disagree
Agencies have clear roles and responsibilities in monitoring and issuing warnings	20	55	10	10	5
Agreements are in place for consistency in warning language and communication channels	15	15	35	15	20
Food security information system is in place	40	35	0	20	5
EWSs are subjected to regular tests	15	25	20	30	10
Warnings are verified to check they have reached recipients	5	30	20	30	15
Warning centers are staffed 24 hours	0	25	10	50	15
Hazard measurement parameters and specifications are regularly documented	10	30	20	35	5
Equipment for hazards and vulnerability monitoring is suitable, and personnel trained in O&M	5	55	20	15	5
Hazards and food security data from regional networks, adjacent territories, and international sources are accessible	16	42	16	5	21
Data are received and processed and warnings disseminated timely, in meaningful formats, and in real or near-real time	15	25	15	35	10
Data analysis, prediction, and warning are based on accepted scientific and technical methodologies	10	65	15	5	5
Average	**14**	**37**	**16**	**23**	**11**

Of concern is the absence of 24/7 warning services in most countries, with 75 percent of the respondents stating that warning centers were not staffed for 24 hours; yet, this is one of the important requirements of an effective EWS. With the exception of Rwanda and Swaziland where a 24/7 EWS service exist, in other countries, warning centers operate for 12 hours mainly due to limited staff and funds to pay for overtime. This is probably because disaster profiles for Rwanda (MIDIMAR, 2013) and Swaziland (NDMA, 2011) are dominated by many short lead time events like fire, floods, earthquakes, landslides, Hail storm with strong winds, lightning and thunderstorms, traffic accidents, diseases and epidemics that disrupt people's lives and livelihoods, destroy the infrastructure and interrupt economic activities and retard development.

Therefore, it is worth noting that food security EWS 24/7 services are most important for short lead time events such as lightening, storms, earthquakes, tropical cyclones, floods, pests and diseases but not so critical for long lead time events such as droughts. This is explained by the time period taken for these long lead time events to occur, for example drought is a slow onset disaster thus allows time for food security reduction and mitigation measures to be undertaken.

In some countries, for example, Malawi, the weather services operate during working hours due to staff shortages. Although some countries have emergency operation centers (EOCs), these are not operated 24/7 throughout the week and do not operate outside working hours and during holidays, unless there is an emergency. Nonetheless, several countries surveyed aspired to develop their EOCs along the lines of Mozambique's national EOC, which received extremely favorable reviews during the stakeholders' consultation. Although these are likely to slightly develop in different ways depending on the context, there was a strong sense among the stakeholders interviewed that EOCs would have many functions beyond the activation of emergency response and they would serve as the EWS information hubs. If this suggestion is to come to fruition, then there will be a need to mobilize resources for the establishment of EOC infrastructure and technical expertise to support the EOC functions.

3.2.3 EW Information Dissemination and Communication at the National Level

Effective EWS communication rests on the credibility and trustworthiness of the sender, format and wording of the warnings, dissemination methods, education and preparedness of stakeholders, and their understanding of the risks they face (WMO 2010). Almost all EW information providers will have, as a basic public task, the provision of forecast and warning services to the general public. The questions are:

- Is the EW information tailored to the needs of users?
- How is this information communicated?
- Is it communicated directly to the public by the EW information service provider through its own staff or through partner organizations such as emergency management agencies and the media?
- Are online channels of communication (ranging from the traditional websites to social media) being used?
- Except in Somali, respondents from all other studied countries revealed that communication and dissemination of warnings are tailored to the needs of individual communities through multiple communication mediums. Interestingly, it is only in Kenya and Swaziland were warning alerts and messages are tailored to the specific needs of those at risk; with the understanding of the values, concerns and interests of those who will need to take action being incorporated into warning messages in Sudan, Swaziland and to some extent Kenya and Zimbabwe. Additionally, it is only in Djibouti, Kenya, Rwanda, Swaziland and Zimbabwe were private sector resources are used in dissemination of warnings. It is only in Kenya and Ethiopia were 50 and 100 percent of the respondents noted that consistent warning dissemination and communication systems are used for all hazards. In Ethiopia, Kenya, Sudan and Zimbabwe; 100, 75, 100 and 33.3 percent of the respondents, respectively, noted that equipment maintenance is implemented with back-up systems fully installed and operational in the event of a failure. Specificity about nature of threat and impacts is well elaborated in warning issued in Kenya, Rwanda, Sudan and Zimbabwe.

Table 3.3 shows that in most countries in the ESA region, warnings are generally specific to the hazard such as drought and floods. Most of the respondents (76 percent) were of the impression that warnings were specific to the hazard while 64 percent believed multiple communication channels were used to disseminate the EW information. KIs confirmed that many users regard warnings to be credible and trustworthy because they are enforced through government channels and passed to affected communities.

Table 3.3: Dissemination and Communication of EWS Information at the National Level

Subjects	Frequency, percentage				
	Strongly Agree	**Agree**	**Somewhat Disagree**	**Disagree**	**Strongly Disagree**
Communication and dissemination of warnings are tailored to the needs of individual communities	6	41	23	12	18
Multiple communication mediums are used for warning dissemination	23	41	12	18	6
Private sector resources are used in disseminating warnings	6	18	29	41	6
Consistent warning dissemination and communication systems are used for all hazards	6	35	35	18	6
Equipment maintenance is implemented and backup systems are in place in the event of a failure	0	17	41	18	24
Warning alerts and messages are tailored to the specific needs of those at risk	0	29	24	35	12
Messages incorporate the understanding of the values, concerns, and interests of those who will need to take action	6	41	23	24	6
Warnings are specific about the nature of threat and impacts	6	70	12	12	0
Average	**7**	**37**	**25**	**22**	**10**

The major criticisms were:

- Some 71 percent of participants felt the warning messages and alerts are still generic and not clearly tailored to the needs of the users to trigger action.
- Key informant interviews (KIIs) revealed that the traditional forms of disseminating the EWS information (radio, telephone, sirens, visual warnings, drums, and messenger runners for some remote locations) are still dominant. The uneven coverage of these traditional forms of communication, especially in remote areas, means that warnings are not received on time. However, the coverage in some countries has improved due to the RANET radios, for example, in Kenya and some parts of Zambia.

- The use of social media outlets such as *Facebook*, *Twitter*, and *WhatsApp* is still in its infancy due to poor mobile network coverage as well as the prohibitive Internet costs. Interestingly, these are the areas where the EWS information is needed most (see Box 3.1).

Box 3.1: "We've No Options but to Rely on Indigenous Knowledge"

In Mbeta Island, Namakusi Village, people have observed changes to the climate over the years. The rains used to start in October, following which planting would commence. This was no longer the case. In 2016/17 rainy season, the rains commenced on December 15 instead of October. The farming season has shortened, and yields have declined as a result. The floods and water have become less, and fish stock has dwindled to unprecedented levels. Droughts have increased over the years. Animals are affected by lack of grass, and some natural vegetable species have disappeared. Pests have increased because of high temperatures.

Based on their indigenous knowledge, they can tell when the wet season is approaching. This includes abundant clouds, no winds in September, or when winds are south-easterly and if there are tumbimbi birds around October. They can also tell when the pests outbreak is looming. Although they recognize that indigenous knowledge can sometimes be misleading, they have no other options. Mbeta Island has poor TV and radio signals. They cannot watch TV or listen to the radio. However, they were not using social media (Facebook and WhatsApp) because they have no money to buy data bundles. In any case, social media is for children who are literate and not for adults (who maybe illiterate). When days are good and people receive radio signals, they access weather information. This information is not always true; it is sometimes misleading. One time the radio informed that the wind would be blowing from north to south and the opposite happened. This affected the fishermen.

They also felt excluded from development programs compared with people on the mainland. The most important thing they indicated as needed were seeds and farming tools and these should be delivered not later than August in preparation for the rainy season.

Source: *Focus Group Discussion*

Part of the solution to increasing the use of social technologies in remote areas is to strengthen collaboration and partnerships between the public sector and private sector. In many countries, there is increasing collaboration between telecommunications regulators, mobile phone providers, and the national disaster management authorities in the dissemination and communication of the EWS information. In Zimbabwe, for instance, the Department of Civil Protection and ECONET Wireless, one of the mobile phone providers, have developed partnerships in EWS information dissemination. Before the message is sent out to subscribers, the Department of Civil Protection and ECONET Wireless agree on the message to be disseminated. The role of the Department of Civil Protection is to craft the messages in three main languages (English, Shona, and Ndebele) while the role of ECONET Wireless is to disseminate the message to the subscribers. Many stakeholders, however, strongly feel these public-private collaborations and partnerships are less developed in the food security EWS.

Some EWS users in Mbeta Island would not use social media due to illiteracy. If EWS information is about generating action of users, then the EWS stakeholders should find appropriate means of communicating, including the use of the language understood by users. Along these lines, many EWS users, ranging from those in Mbeta Island to top officials, criticized the EWS producers for communicating their products in a language that is not clearly understood (Box 3.2).

Box 3.2: Seasonal Forecasts Not Packaged according to Language of Users

While the Meteorological Service Department (MSD) information is scientifically sound, it is not packaged in the language that is useful to farmers. When they say 'below normal', 'normal', or 'above normal', what does this mean? These are just words and are not useful at all—this is not explicit. The MSD should disseminate information in a language that is understandable to ordinary farmers. They should clarify climate change words such as 'El Niño', 'La Niña', and 'variability' and relate these to the local setting. Using technical jargons that are not understood by farmers and drawing examples from China are not useful to the Zimbabwean farmers. Information should be properly packaged to suit its users. Sending graphs or maps with colors from the MSD is not suitable for local people. Something easy to understand such as dates when people will receive or not receive rain and how much rain will be received will be more useful to the farmers. However, this is not enough. This information should be translated to the language of the farmers. Write Shona to Shona farmers, Ndebele to Ndebele farmers, and so on to cover all the 16 languages in Zimbabwe. If the MSD does not have resources, they should request farmers to translate the materials. In any case, the information disseminated by the MSD should be quality-checked by farmers themselves.

Source: Member, ZFU.

3.2.4 EWS Response Planning at the National Level

While the effectiveness of dissemination and communication of EWS information plays a critical role for users to take action, it is important to translate this information to mitigation and preparedness and response plans because these strongly affect the livelihood options, safe behavior, and how best to avoid damage and loss to property. This requires four critical inputs:

- Preparedness and response planning;
- Public education and awareness;
- Simulation exercises; and
- EOC

In terms of preparedness and response planning, Table 3.4 shows 76 percent of the respondents believe that the majority of the ESA countries have some form of systems for translating the EW information into preparedness and response plans, with contingency plans being the most popular ones. KI interviewees, however, criticized the quality of contingency plans stating that some of the contingency plans are not based on plausible scenarios that precisely identify vulnerable communities, livelihoods, critical infrastructure, and gaps in resources, capacities, and roles and responsibilities. Most worrying was that the national contingency plans were rarely informed by sector and subnational plans, because the systems for these plans were either less developed or nonexistent. These criticisms call the attention to:

- The importance of building sector and subnational capacity in developing contingency plans;
- The need to develop a generic contingency plan template to guide the ESA countries in developing multi-hazard and multi-sectoral contingency plans. This might require the ESA countries to consider their participation in the African Risk Capacity (ARC),[23] which has the technical expertise in contingency planning.

[23] The African Risk Capacity (ARC) was established as a Specialized Agency of the African Union (AU) to help member states improve their capacities to better plan, prepare and respond to extreme weather events and natural disasters, therefore protecting the food security of their vulnerable populations. ARC provides member states access to disaster risk finance that can be deployed in times of natural disasters and extreme weather events. This financing coupled with predefined contingency plans enables governments to respond to affected households on time thereby preventing household loss of livelihoods and building resilience. The ARC provides a link between early warnings

- The need to make contingency plans appealing and engaging readings, not voluminous sets of directives that could be less useful during emergencies because they are often hardly understood by busy decision makers and therefore remain as ‘decorations’ on the shelves because these are often times considered useless to address evolving adverse situations, thus seldom activated during emergencies. One way of realizing the value as a tool of contingency plans is through regular simulation exercises, involving all key stakeholders.

With respect to public education and awareness, 65 percent of the participants felt that the public education programs were appropriate. KIs also stated that interest has grown in the education sector to introduce disaster education, particularly following the Hyogo Framework for Action 2005–2015. At the higher education level, a substantial number of universities in the ESA countries have introduced disaster studies. This progress is partly attributed to the advocacy in building local disaster risk related capacity by the Periperi U, a partnership of African universities established in 2006. At least 12 universities of Ethiopia, Ghana, Kenya, Madagascar, Mozambique, South Africa, Tanzania, Uganda, Zambia, and Zimbabwe offer disaster studies. In contrast, the progress of introducing disaster education at primary and secondary education level has been slower although this has the potential of wider and timely dissemination of EWS products, particularly considering the high appetite for the use of social technologies among children.

With the exception of Djibouti, Ethiopia and Somali, in all other studies countries, development of national emergency preparedness and response plans is informed by hazard and vulnerability maps; and across the board, target communities appropriately respond to issued early warnings. Surprisingly, EW information is built in school / university curricula only in Djibouti (100 percent), Kenya (50 percent) and Rwanda (100 percent) with Regular public awareness /education campaigns being conducted only in Rwanda, Sudan and Zimbabwe. Regular simulation exercises are undertaken to test the effectiveness of the EW systems in all studied countries except in Somalia.

In terms of public awareness, this is well established in most ESA countries, although these tend to be biased toward rapid onset events such as floods and cyclones. Strengthening public awareness requires the development of broad-based public education strategies, involving multiple stakeholders across the public sector, private sector, NGOs, civil society, and cooperating partners.

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through its advanced satellite-based software, Africa Risk View, and contingency planning for early action with objective and predictable financing through its insurance payouts.

Table 3.4: Applying EWS Information in Response at the National Level

Subjects	Frequency, percentage				
	Strongly Agree	Agree	Somewhat Disagree	Disagree	Strongly Disagree
Hazard and vulnerability maps are used to develop national emergency preparedness and response plans	29	47	6	18	0
Target communities respond effectively to early warnings	12	18	40	24	6
EWS information is built in school/university curricula	0	24	29	12	35
Regular public awareness/education campaigns are conducted	18	47	0	29	6
Regular simulation exercises are undertaken to test the effectiveness of the EWS systems	0	26	26	16	32
Average	**12**	**32**	**20**	**20**	**16**

Some 74 percent of the respondents indicated that simulation exercises were regularly conducted to test the EWS. The added value of simulation exercises is their role in testing and validating the planning assumptions. Exercising enhances the awareness of the roles and responsibilities of responders, tests SOPs, and action triggers and builds morale among responders. The recent armyworm outbreak in southern Africa has underscored the importance of simulation exercises to develop coherence among responders. In Zambia, the armyworm outbreak exposed weakness in preparedness and contingency planning at the national, subnational, and sector levels. The 'bottlenecks' in information sharing, coordination, communication, and logistics could have been identified and possibly addressed during simulation exercises. The contribution of simulation exercises is their potential to creating demand for EWS information to meet the needs of the users. The simulation exercises are likely to influence the way information is packaged from the producer to the end user. If simulation exercises should become a constitutive element of the EWS in ESA, then the capacity for developing simulation exercises requires development. This will require developing and utilizing skills in universities, NGOs, the private sector, and cooperating partners.

While simulation exercises are fairly developed in some ESA countries, these tend to focus on rapid onset events such as floods and cyclones (for example, in Mozambique) and dam failure (for example, Kariba Dam in the Kariba Gorge of the Zambezi river basin between Zambia and Zimbabwe). Simulation exercises are rare for slow onset events like drought and insect infestations. For drought, for example, a simulation exercise involving responders, transporters, warehouse authorities, and distribution centers would reveal the gaps in the efficient distribution of humanitarian aid.

3.2.5 EWS Governance Mechanisms at the National Level

While the ESA countries have witnessed remarkable progress in EWSs since the adoption of the Hyogo Framework for Action in 2005, there are also glaring gaps and shortcomings that should be addressed. On the positive side, Table 3.5 shows that 55 percent of the participants indicated that a legal or policy framework that had an EWS element existed in their countries. Along these lines, 50 percent agreed that a national committee with an EWS remit existed suggesting that in some countries, the institutional arrangements are fairly developed from the production of EWS information to activation of response plans. This was corroborated by data from sampled countries (Ethiopia, Kenya, Madagascar, Malawi, Mozambique, Zambia, and Zimbabwe), where key agencies involved in the EWS are clearly identified and their roles clarified in legal and policy frameworks. The most relevant sectors and agencies include meteorological services, hydrological services (water), agriculture, health, and food and nutrition. Most of these sectors have legal frameworks that outline their mandates on the EWS. However, the absence of an overarching legal or policy framework that brings together the EWS stakeholders means the EWSs in some countries are fragmented along sectoral lines.

Only Ethiopia, Kenya, Rwanda and Swaziland have a National all-hazards EW committee with a remit on food security that highlights economic benefits of early warning to senior government and political leaders. However, it is only in Ethiopia, Kenya and Rwanda were capacities of agencies are assessed with capacity building plans developed and resourced. In addition to Ethiopia, Kenya, Rwanda and Swaziland, Sudan has also integrated Early warning information into national economic planning; and, supported and financed local decision-making and implementation of early warning systems. In Somalia and Swaziland, all respondents noted that Government funding mechanism for EW systems are neither developed nor institutionalized. Majority of respondents in Kenya (75 percent), Rwanda (100 percent) and Sudan (100 percent) reported that regional and cross-border agreements are established to ensure early warning systems are integrated. Only Ethiopia, Rwanda and Sudan have embraced Public-private-partnerships in EW system development with Strategy for obtaining, reviewing and disseminating data on vulnerabilities only operational in Djibouti. With the exception of Rwanda, Somalia and Zimbabwe, respondent from other studied countries were fully aware of the existence of the EW legal or Policy framework.

Even without overarching frameworks, many ESA countries have coordination systems for information sharing. These are mainly part of the national DRM platforms. In some countries, the national platform meetings are normally chaired by senior government officials, and in other cases, these are co-chaired by the senior government officials and the UN Resident Coordinator. Further, some countries have established national EW committees or working groups, which also report at the national platform meetings (Figure 3.1). However, some countries such as Malawi and Zimbabwe do not have a dedicated EWS working group or committee similar to the Zambian structure.

Table 3.5: Performance of EWS Governance and Investment at the National Level

Subjects	Frequency, percentage				
	Strongly Agree	Agree	Somewhat Disagree	Disagree	Strongly Disagree
National all-hazards EWS committee is in place with a remit on food security	20	30	30	5	15
Economic benefits of EW are highlighted to senior government and political leaders	24	18	18	34	6
EW is integrated into national economic planning	12	29	24	29	6
Local decision making and implementation of EWS is in place and resourced	6	29	29	12	24
Regional and cross-border agreements are established to ensure EWS are integrated	0	35	24	12	29
Capacities of agencies are assessed and capacity-building plans developed and resourced	6	29	18	29	18
Government funding mechanism for EWS are developed and institutionalized	0	46	24	24	6
PPPs are utilized for EWS system development	6	29	24	29	12
Strategy is in place for obtaining, reviewing, and disseminating data on vulnerabilities	5	25	35	30	5
EWS legal or policy framework exists	10	45	15	25	5
Average	**9**	**32**	**24**	**23**	**13**

This study found that strong subnational structures are one of the prerequisites of an effective EWS. This recognition has found currency in most ESA countries. Many countries are strengthening the subnational structures at the provincial, district, and community levels. Depending on the legal frameworks, these structures take various forms—some of the EWS functions are assigned to disaster risk reduction (DRR) committees and ward development committees, while others are sector specific such as food and security committees, water users committees, river catchment councils, and environmental committees. In Ethiopia, there is a clear EWS structure from the federal level to the *kebele* (ward) under the National Disaster Risk Management Commission. The *kebeles*, for example, are actively involved in the National Productive Safety Net program where they use the products from the EWS, for example, in targeting members of their communities eligible to participate in public works programs. Although many countries recognize the role of subnational structures in the EWS, because these are outlined in their policy frameworks, these structures do not exist in practice, mainly due to resources constraints.

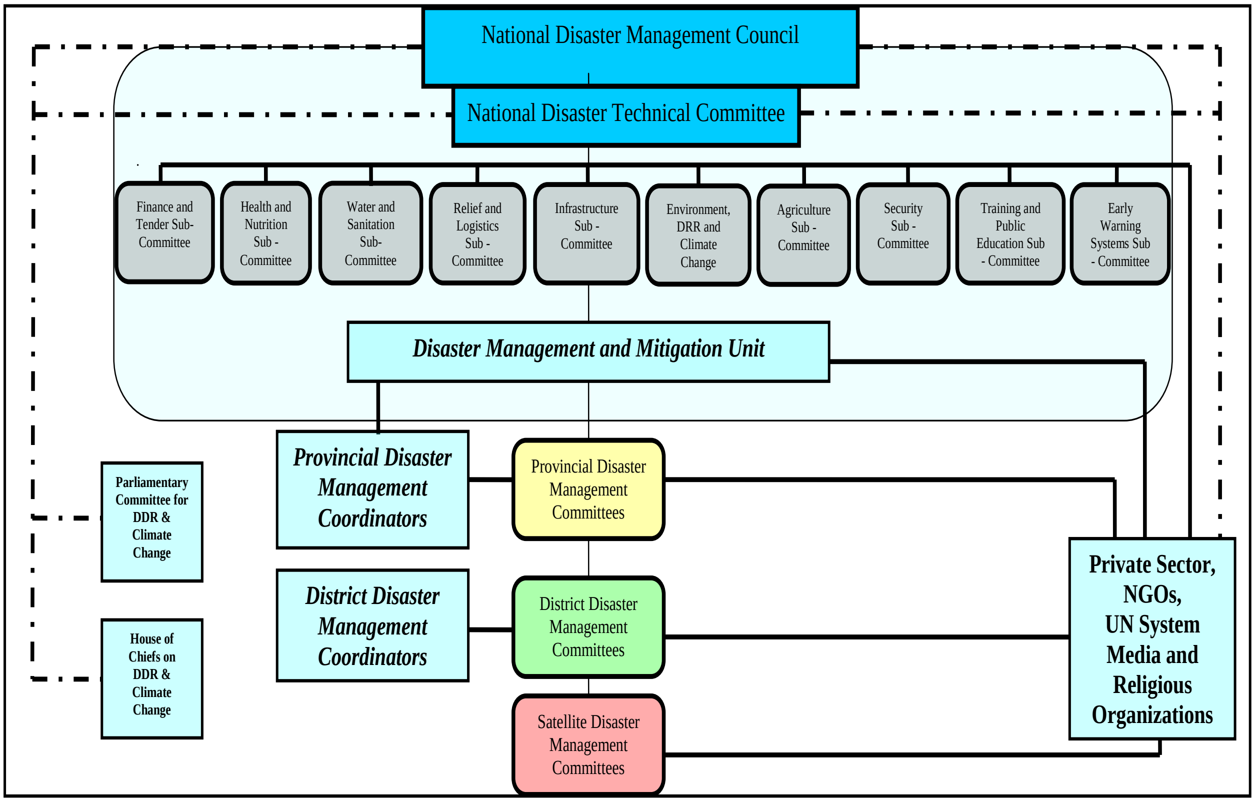
Uganda has The National Disaster Preparedness and Management Policy, 2011, which talks about collection of EW information by the mandated institutions, and dissemination by the National Platform for Disaster Risk Reduction and the media. The policy mentions other activities such as conducting Risk mapping and vulnerability assessments, research and documentation, as a mode of obtaining EW information and developing EWS. However, there is no clear established channel on how the collected information should continue to flow to the coordination centre (NECOC), in the Department of Relief, Disaster Preparedness and Management. The Policy also stipulates that the Uganda Broadcasting Council and Uganda Telecommunications Commission will establish Memoranda of Understanding (MoUs) with FM Radio Stations and Mobile Phone Telecommunications Companies to enable the use of their facilities to send out early warning messages whenever the need arises. Currently, the Electronic Media and FM Radios, offer free Airtime as Talk Shows to disseminate EW information upon release of weather forecasts, for example El Nino, and La Nina events, and any other sensitisation that the department finds necessary to communicate to the public ahead of time.

The Department of Relief, Disaster Preparedness and Management has started on the process of drafting the National Disaster Preparedness and Management Bill; therefore the legal framework should clearly stipulate how the responsible institutions shall ensure the flow of EW information on a regular basis to NECOC.

In addition, the legal framework needs to task the Telecommunication Companies to send out Early Warning messages as mentioned in the NDPM Policy. The Bill should assign these companies roles as a contribution from the Private Sector to Disaster Preparedness and Management. Involving the Private Sector in Disaster Risk Reduction is emphasized by the Sendai Framework for Disaster Risk Reduction, 2015 -2030.

The Policy assigns NECOC a coordination role, and technical (modeling) in addition to the responsible institutions. However, capacity building of NECOC staff to scientifically develop, and analyze the provided EW information is still low.

Figure 3.1: Organizational Structure of the EWS in Zambia



Source: ZMD:

Some 65 percent of respondents felt that the EWS activities were not adequately resourced. Evidences from the consultation with stakeholders and from the literature (for example, Tefft et al. 2006) show that efforts to develop the capacities at the subnational level have generally been externally driven, with tremendous challenges of sustainability. The 1990s Regional Early Warning System in the SADC countries are a case in point where the benefits of the program were not financially sustainable when the support from the Danish government and FAO ceased. Several agencies, NGOs, International Federation of Red Cross and Red Crescent Societies (IFRC), UN agencies, and the World Bank have been involved in the EWS capacity-building programs in different forms. In Somalia, understandably because of the civil conflict, food security assessments are mainly conducted by international agencies, led by FAO with minimal participation from the government (Box 3.3). However, even in stable environments, the external agencies still dominate the EWS activities. In the rural district of Binga and Nyaminyami in Zimbabwe, a huge amount of donor resources has been provided since Zimbabwe's independence from Britain in 1980 in strengthening decentralized systems; today, these districts are still dependent on humanitarian assistance. Similarly, in Kenya's arid districts, such as Turkana, the food security challenges remain after protracted donor support over the years.

Box 3.3: Risk Assessments Led by International Agencies

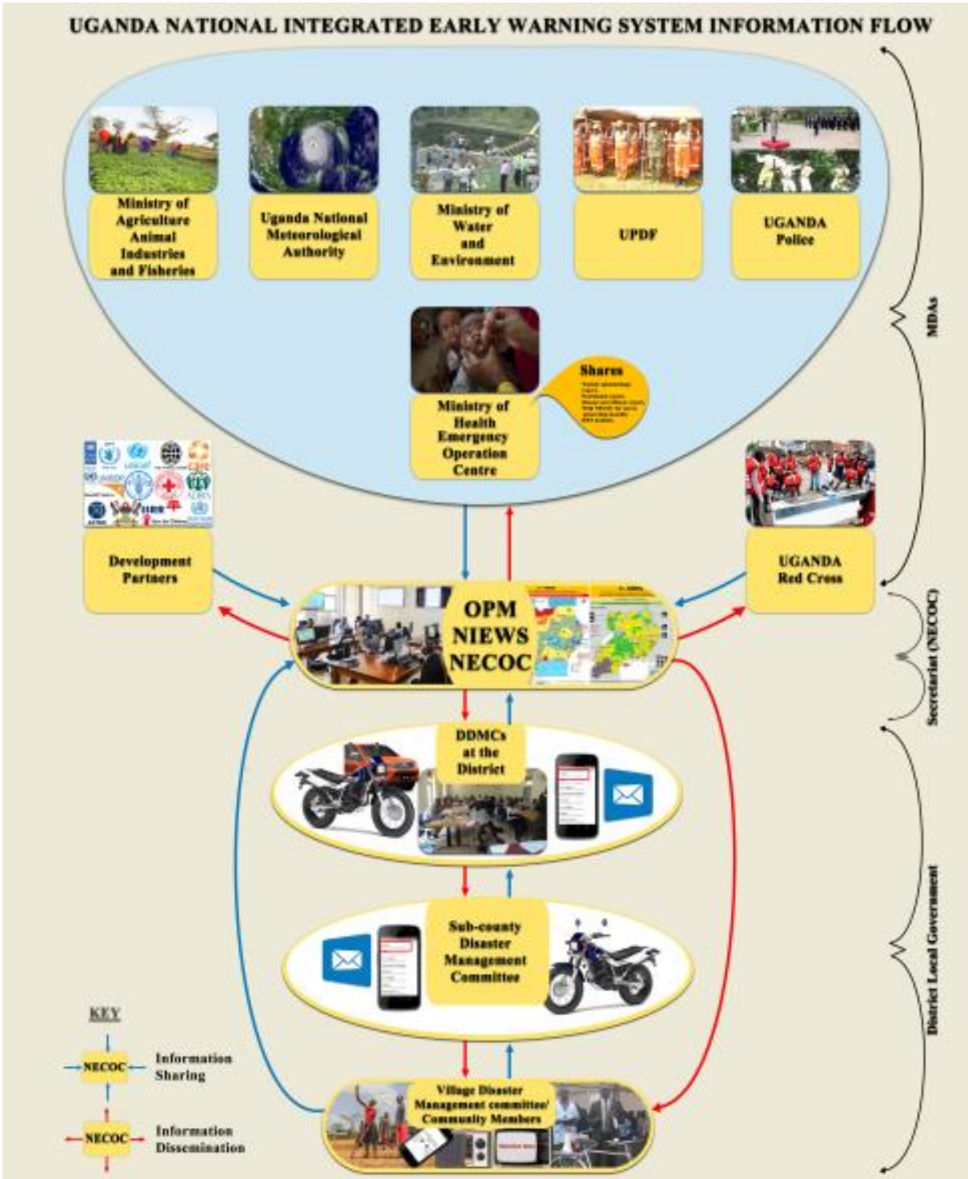
Currently, NGOs that have the means, knowledge, and resources are very much involved in assessing hazards and vulnerability for food security, and the findings obtained from these assessments are set only to benefit the NGOs that created this system and not the communities and the government. On the other hand, the government agencies' staff cannot assume their roles even though their roles on the [EWS] subject are clearly identified, and the reason is because they do not have the means, knowledge, and the resources to achieve these objectives. There are some hazard and vulnerability assessments data collected by government agencies but they are collected in an unconventional way.

Source: Survey Questionnaire.

Indeed, there are 18 pilot projects that are being conducted by the World Bank's Pilot Program for Climate Resilience, including in Zambia and Mozambique. In this project, the staff costs are borne by the government while the operating costs are borne by the World Bank. When the funding ends, it is conceivable that the benefits accruing from these interventions are unlikely to be sustained. The reasons for this, as this study found, are:

- About 60 percent of stakeholders felt that senior government and political leaders are not aware of the economic benefits of the EWS as cost-benefit analysis of previous disasters are rarely conducted, and therefore, there is limited 'buy-in' from the decision makers. Not only is better evidence on the cost-benefit analysis of the EWS needed in supporting decision making but also the method of delivering these benefits should be communicated in the language these stakeholders will understand;
- The EWS is viewed as an emergency and seasonal activity, with about 59 percent of the participants agreeing that the EWSs were rarely integrated into national economic planning. This makes the EWS an ad hoc activity, relying on emergency budgets, which often creates competition between the EWS and regular development agenda. Some people interviewed in this study strongly advocated for a shift from viewing the EWS as an ex post event. Rather, the EWS should be viewed as an ex ante process that is mainstreamed in development frameworks; and
- **Limited alternative sources of funding.** Some 65 percent of the participants felt that the capacities of the agencies involved in the EWS were not well resourced. At the same time, 69 percent of the participants felt that the PPPs were underutilized in EWS development. As the results of this study attest, there is also limited engagement in PPPs to help mobilize resources internally. This means the legal frameworks should be clear on how these partnerships could yield maximum EWS benefits.

Across Uganda, significant levels of investment into systems that collect and share early warning information on a range of hazards including floods, droughts and diseases exist.



Source: NECOC

The state of early warning systems in the country was analysed in terms of organization, kind of early warning information delivered, dissemination channels as well as technical and financial sustainability. According to Lumbrosso (2016), EWSs in Uganda can be categorized as:

1. Drought and Food security related early warning systems

- Karamoja Drought Early Warning System (DEWS). Established in 2008, this system collects and analyses data on 31 indicators to monitor hazards and vulnerability that fall into five main categories namely, crops, livestock, human health, water and livelihoods. Every month, data is taken from a representative sample of 10 households per parish, (75 parishes in total are sampled), recorded, analysed by district departmental heads and communicated as a monthly drought bulletin through a variety of means, including emails to decision makers; and, to communities through radio programs, dramas in role plays and mobile phones. The bulletins provide four drought risk classifications, namely, normal, alert, alarm and emergency. The system is largely implemented by district local government with oversight from line ministries and financial by a Non-Governmental Organisation (NGO) ACTED, supported by FAO. DEWS appears technically sustainable in that it has a track record of using District level and community-based actors to collect information. Although an exit strategy was developed in 2012 aiming at a phased handover to the government both in terms of the financing of DEWS, and independent technical management of the activities, this has not been implemented and donor funding has come to an end.

- Famine Early Warning Systems Network (FEWS NET). Established by USAID in 1985, FEWS NET helps decision-makers plan for humanitarian crises and provides evidence-based analysis through monitoring of hazards that may have an impact on food security (e.g. droughts, floods, price shocks, livestock epidemics). This is integrated with information and data on markets and trade, nutrition, livestock and crop production, and livelihoods to evaluate current and future food security conditions. The indicators used include: terms of trade, satellite rainfall estimates, Normalized Difference Vegetation Index (NDVI), price data, nutrition indices, monthly price data of staple foods, livestock and livelihood commodities such as firewood, charcoal and wage labour. FEWS NET uses the Integrated Food Security Phase Classification (IPC) scale to determine food insecurity.

  FEWS NET relies on a network of partners to access the data needed including market prices of staples in Karamoja from the World Food Programme (WFP) and Farm gain Africa Ltd for other major markets in Uganda. FEWS NET uses seasonal rainfall forecasts provided by the Uganda National Meteorological Authority (UNMA) as well as forecasts by the European Centre for Medium Range Weather Forecasts (ECMWF), National Oceanic and Atmospheric Administration (NOAA). UNMA forecasts are accessed after the meetings of the Greater Horn of Africa Climate Outlook Forum (GHACOF). Sometimes there are updates on the rainfall forecast between the meetings of the GHACOF. Based on the seasonal rainfall forecasts and by asking what people have planted and how it has germinated, FEWS NET develops general prediction regarding crop performance. These are validated in the field.

  A bulletin on food security and vulnerability in Uganda is issued quarterly and this is shared with policy makers. However, the results produced by FEWSNET do not appear to be widely used by the Ugandan Government. FEWSNET has a commitment to deliver monthly reports to USAID and hence cannot always wait for the official approval of the Ugandan Government before issuing bulletins.

  FEWSNET is wholly funded by USAID based on a five-year funding cycle. Its reliance on donor funding could affect its long-term sustainability as any change in donor funding priorities would result in its downscaling or termination of the early warning activities.

- World Food Programme (WFP) Vulnerability Analysis and Monitoring (VAM). The WFP on a regular basis either as standalone WFP activities or in partnership with other agencies such as FEWS NET collects and analyses food security, market and nutrition data. Every six months in partnership with UNICEF, WFP conducts a food security and nutrition assessment for Karamoja which collects data on several regional indicators. On a monthly basis, WFP collects food price data on various commodities in major markets across the country such as maize, beans, rice, goats and sorghum and issues a monthly bulletin showing price trends. These bulletins are distributed by email to policy makers central and district level governments, food security and agricultural livelihoods cluster members and donors; and is downloadable from the WFP's Vulnerability Assessment and Monitoring (VAM) website. The WFP's VAM uses staff at a district levels. From a technical point of view, the methods utilised to collect the data are technically sustainable. However, without support from WFP, this data would not have been collected.

- Disaster Risk Financing (DRF). This is established under the support of Third Northern Uganda Social Action Fund Project (NUSAF III) with a loan from the World Bank. The Department of Relief, Disaster Preparedness and Management through NECOC implements a disaster risk financing sub component in Karamoja by collecting, analyzing and storing risk-related information. The primary indicator for whether DRF should be triggered within Karamoja is based on NDVI, which is freely available from various remote sensing sources on line. A monthly NDVI analysis is performed during the crop growing season and findings shared with the members of the DRF Sub-Committee.

  The secondary indicator is IPC (Integrated Food Security Phase Classification), that utilizes information collected by other EWS such as DEWS, FEWSNET and WFP (e.g. food consumption related indices, coping strategies, the number of children admitted to feeding centers, staple food prices, terms of trade).

  A DRF Sub-Committee was formed in December 2015, and comprises of organizations whose activities contribute to the country's food security. The organizations include OPM, FAO, WFP, FEWSNET, Ministry of Health, Ministry of Water and the Environment, ACTED, UNDP, UNMA, Makerere University, Ministry of Agriculture, Animal- Industry and Fisheries, and the Uganda Bureau of Statistics. The major function of the DRF Sub-Committee is to approve the findings in the DRF report upon compilation of trigger indicators, and it's also another platform for information dissemination on Karamoja food security status.

  However, currently there is no established information flow from the local level to national level. The EWS is still reliant on undertaking fieldwork by the national technical team. In addition, DRF does not encompass forecasts. Drought forecasts provide a longer lead time in which to implement public works programmes in areas that are predicted to potentially be affected by droughts.

  Worth noting is that the above mentioned Drought EWS are implemented in one region of the country (Karamoja region), yet with climate change the risk has changed both in occurrence and magnitude in the cattle corridor that extends from the East, Central, to South Western areas of the country.

2. Flood early warning systems

At the national scale, no flood forecasting and warning system exits, neither is there a flood forecasting and warning system specifically for the majority of areas at risk of flooding. The Department of Relief, Disaster Preparedness and Management, concluded Hazard, Risk and Vulnerability Profiling at District level and these indicated areas at risk of flooding. Subsequently, studies (Goretti, 2013; Wagemaker and Wasswa, 2016) have been conducted, with limited mapping and identifying the areas at flood risk.

Below are some of the localized initiatives that have been implemented:

- Butaleja District Flood Early Warning System established in 2014 on River Manafwa as a joint venture between Government of Uganda and UN ITU to provide communities with sufficient time to move to areas outside the flood plains when high water levels are detected upstream. It should be noted that the system does not provide forecasts for flood levels, meaning that it does not provide a long lead time to allow for formulation of appropriate decisions with a bearing on improving food security. Once the water reaches a certain level on the sensors, a signal is sent to the central command center to activate a siren which can be heard in a 5 km radius. The siren gives a message in English and the local language to warn communities about a possible flood and whether they need to evacuate to higher grounds. The EWS is relatively simple and would appear to be technically sustainable. However, no budgetary provisions have been made at a district level to cover any maintenance issues that may arise.

- Pilot forecast-based financing scheme for floods for north-east Uganda. This has been piloted by the IFRC Climate Center, the German Red Cross and the Uganda Red Cross Society focusing on 16 villages in Abim, Katakwi, Kotido and Soroti (Jongman, 2016). The pilot relies on the Global Flood Awareness System (GLOFAS) run by the European Centre for Medium Range Weather Forecastin (ECMWF) which use probabilistic forecasts of relevant variables (rain fall, temperature) with a simple hydrological and hydraulic model to produce probabilistic forecasts for 40 days in advance. The GLOFAS is set to produce warning based on the probability of exceeding certain probabilities of flow – return periods of 1 in 2, 1 in 5 and 1 in 20 years (Jongman, 2016). To improve its accuracy, the model is validated with phone SMS text messages and this informed the decision by the German Red Cross to enter into partnership with Ureport – an SMS based communication platform launched by UNICEF in 2010. Since GLOFAS Model utilizes a forecast of the flood hazard, it could be a useful tool to implement low regrets actions in flood-risk areas.

  The GLOFAS web site is freely accessible; however, from a technical sustainability point of view, its accuracy is low. It would also require the Ministry of Water and Environment to set aside sufficient budget to allow its members of staff to assist the ECMWF with improving its forecasting accuracy for large rivers in Uganda. Although the IGAD/ICPAC recently rolled out Flood forecasting models such as GeoCLIM to Member States, these are still based at NECOC awaiting a training of technical experts from line institutions and Districts. Thus, this will take some time since it requires financing of short trainings.

3. Weather forecasts and warnings for farmers

Approximately 80 percent of Ugandans depend on agriculture for income and food security; hence any threat to agricultural production degrades Uganda's socio-economic status and puts a huge population at risk of poverty and hunger (ACCRA, 2014). In many low-income countries effectively disseminating weather forecasts and warnings to farmers is challenging and Meteorological Authorities often generate warnings solely in English using technical language.

Below are details of two weather forecasting and warning systems aimed at farmers in Uganda:

- Africa Climate Change Resilience Alliance (ACCRA) weather forecast and warning system. Under this ACCRA system run by UNMA, at the beginning of each season, a half day meeting is held comprising of key sector actors, the output of which is a simplified forecast for each Uganda district (ACCRA, 2014). The forecast from GHACOF is translated into local languages (so far 22 out of 54 locally spoken languages in Uganda) and the translations are produced on pre-recorded audio CDs which are then sent to radio stations and posted on the UNMA website as audio broadcasts (Atyang, 2015). It is worth noting the system is one of the few in Uganda that utilizes forecasts and generates warnings aimed at a specific user group. Since it uses regional forecasts from GHACOF, it should be technically sustainable; However, ACCRA being a Non-Governmental Organization it is not clear if budgetary provisions have been made within the relevant government department as regards to funding.

- Mobile 3-2-1 service. This is being developed based on lessons learned in Malawi and Madagascar by Human Network International (HNI) – an international development organization specialized in technology dissemination in partnership with Airtel Uganda – a telecommunication company. HNI is currently working with Airtel on a free SMS-based information and warning system covering only Airtel subscribers. The system will be owned and operated by Airtel in the districts bordering Lake Victoria and along the cattle corridor. The service provides users with 10 free SMMS per month containing information micro-financing, health, water; however, in the future, it will provide information on weather warning, therefore, it has potential raise sizeable awareness on risks posed by weather including risks to agriculture. The system is one of the few primarily reliant on a private sector organization. However, pilots in Malawi and Madagascar have shown that it has the potential to be both financially and technically sustainable.

4. Disease warning tools

There are a number of tools in Uganda that are used or are being piloted for the surveillance of livestock diseases. It worth noting that these tools are not strictly EWS. These are briefly described below:

- Pictorial Evaluation Tool (PET). This is a pilot phase in Karamoja as an objective, ground-based system to provide objective means of rapidly of assessing crop yields and livestock condition by comparing observations in the field with photo-indicators of actual crops and animals. Training for District and MAAIF Officers by FAO on use of the tools are currently under way.
- EMPRES-i event mobile application. Commissioned by the Irish Government and FAO in 2013, it was piloted in 10 districts as a smart phone based tool to report animal disease outbreaks. It allows for workers to use smart phones to communicate disease outbreaks to the Uganda National Animal Disease Diagnostic and Epidemiology Centre. Although it was found to be useful, it unclear if continues to be used and how sustainable it is from a financial and technical point of view.

5. MAAIF Early Warning System.

The Planning Unit at the Ministry of Agriculture, Animal Industries and Fisheries (MAAIF) issues warnings after analyzing implications of UNMA season forecasts on agriculture. The warnings are accompanied by advisory messages and mitigation measures for crops, livestock and fisheries. Within each growing season; crop, livestock and fish monitoring takes place. A post-harvest assessment is also carried out.

The IPC working group composed of MAAIF, FAO, WFP, Makerere University and other key actors handles data analysis at national level. It is worth noting that access to adequate data especially for the Karamoja remains a challenge. Additionally, schedules for regular monitoring of livestock, fish and crops are nonexistent. Notably, triggers for response have never been set. Among the reports developed, there is one specifically focusing on Karamajo as it is the most vulnerable region in the country. The information generated is disseminated as advisories twice a year through newspapers and emails to local government, as well as via local radios.

Although the MAAIF EWS uses seasonal climate forecasts from UNMA just like most other EWSs in Uganda, it does not forecast the risk. Additionally, it appears under-resourced and lacks a feedback mechanism which makes it difficult to ascertain how effective it is in reaching vulnerable communities and engendering a response.

6. NECOC Disaster Monitoring System

NECOC Disaster Monitoring System developed with support from UNICEF is a community-led alert system managed by the Department of Disaster Preparedness and OPM. It is a country-wide web-based application system that receives and send SMS messages with the use of a short code on mobile-based communication tools. In 2016, OPM applied to the Uganda Communication Commission for a toll free number so that users can send at no cost (UNICEF, 2016).

At the district level, data are collected by Chief Administrative Officers using the Open Data Kit (ODK) to collect for detailed information to inform response to a disaster. The ODK has a number of forms that covers issues related to a hazard like:

- How many households have been affected?
- Origins of the data
- Coordinates of the hazard
- Number of mothers affected
- Number of children affected

The ODK uses Delsnventar platform for collecting and generating data sets. NECOC has an ICT infrastructure to operate the system and has a dedicated technical team, so the system is technically sustainable. The District Disaster Management Committee has the responsibility to profile, validate the nature of the disaster, and there after decide on the appropriate response. The long term goal is to get one trusted member of the community at a Sub-County level operating the system (i.e. one person per 60,000).

However, the system does not forecast hazards and relies on an individual to feed information in the ODK. The system is currently funded by UNDP and it is unclear if OPM will provide funding to NECOC for future operations.

3.2.1: Challenges faced by EWSs in Uganda:

Most of the challenges in Uganda's EWSs relate to Governance and finance gaps. Good governance is facilitated by robust legal and regulatory frameworks and effective institutional arrangements. Critical challenges include:

- Technological development especially use of mobile phone by most CSOs to collect EW information. This has led to 'individualization' of EWS citing failure of responsible agencies to act in real time. Thus, NECOC with the relevant line ministry take responsibility for any false warnings, accuracy and authenticity of the information, as well as related costs.
- Poor coordination of response and accountability. Early warning information is transmitted to relevant ministries, CSOs and other agencies which quite often use it in bits to develop plans. This makes it impossible to arrive at a coordinated and timely action.
- Lack of constant, guaranteed and adequate funding, results in unsatisfactory equipment and staffing levels. This therefore threatens the sustainability of early warning systems.
- Limited technical capacity owing to the fact most of the country's EWSs do not have a forecasting element to them, making it hard to engender early action. Therefore, inadequate capacities in terms of knowledge and skills continue to be a challenge to supporting the proper functioning of different early warning systems. Additionally, EW methodologies, tools and techniques are often inadequate or poorly integrated. This, therefore, threatens the reliability and timeliness of EW information.

3.3.3: Recommendations:

1. Support incorporation of climate forecasts into most nationally available EWSs and tools to foster formulation and operationalization of early (timely) action. This will necessitate facilitating specialized training on use of forecast models and tools.
2. Produce and disseminate simplified EWS messages that include risk information designed to link threat levels to contingency preparedness and response actions; understood by authorities and end users; and issued from a single (or unified), recognized and authoritative source.
3. Support alignment of technical capacities with financial across national and local governments to facilitate development and out-scaling of relevant EWSs and tools and corresponding response mechanisms.
4. Establish a national early warning committee or secretariat to facilitate coordination with respect to existing EWSs and relevant tools.
5. Strengthen Uganda's institutional framework for disaster management by supporting development of a comprehensive law on disaster risk management and food security related emergencies.
6. Build capacity to downscale global and regional climate change information to national and sub-national level to support decision-making.
7. Develop tools to support vulnerable households and communities to establish household community systems that can respond to emergencies.

3.3 Performance of Food Security EWS at the Regional Level

3.3.1 The EWS and Risk Knowledge at the Regional Level

Conducting regular food security risk assessments is one of the key roles of the regional institutions. Understanding regional hazards and key vulnerabilities requires regular systematic collection and analysis of data to help prioritize EWS needs and guide preparations for disaster prevention and responses. Table 3.6 shows the proportion of responses that indicate weaknesses in the risk assessment thematic subjects, scoring low on the 5-point scale, and the thematic subjects under risk assessment that are ineffective, showing low frequencies of agree and strongly agree.

Most participants (69 percent) agreed that the agencies involved in risk assessments at the regional level have clear roles and responsibilities. This was substantiated by two main reasons.

First, the main agencies involved in the collection of hydrometeorological hazard data are ICPAC and the SADC's CSC. Institutionalized in IGAD and SADC, respectively, both ICPAC and CSC organize annual seasonal climate forecasts, through GHACOF and SARCOF, where they bring together member states and development agencies to report on weather forecasts for the next rainy season, often six months ahead of time. The impacts of GHACOF and SARCOF manifest on the extent to which they inform the National Climate Outlook Forums and help users to decide on their farming activities and dam management options and guide disease preventions such as malaria prevention and control. What is clearly a good practice is the extent to which the GHACOF report outlines actions that should be considered by the users (see Box 2.2), which is not clearly stated in the SARCOF reports. Some of the challenges ICPAC and CSC face are summarized in Box 3.3.

Table 3.6: Effectiveness of Risk Assessments at the Regional Level

Subjects	Frequency, percentage				
	Strongly Agree	**Agree**	**Somewhat Disagree**	**Disagree**	**Strongly Disagree**
Agencies involved in hazard and vulnerability assessments are identified and roles clarified	25	44	6	25	0
Hazards are regularly analyzed and evaluated	13	31	19	24	13
Integrated risk and hazard maps are regularly developed and assessed	19	25	6	50	0
Regional vulnerability assessments are conducted annually and with disaggregated results	0	37	13	37	13
Regional vulnerability assessments are conducted annually on the impact of seasonal climatic hazards	19	31	31	19	0
Industry is consulted during risk assessments	0	7	53	27	13
Results of risks assessment are integrated into regional risk management plans and warning messages	19	37	25	13	6
Central database is established to store risk information and is available to users and is regularly updated	0	13	25	43	19
Average	**12**	**28**	**22**	**30**	**8**

Similarly, the roles and responsibilities of agencies involved in vulnerability assessments are outlined across the RECs. In IGAD the FSNWG, is a forum for building consensus on food and nutrition policy and interventions and updates the food security and nutrition situation analysis (EW). With a membership of approximately 80 organizations (IGAD, UN agencies, NGOs, donors, and research institutions), the FSNWG has been serving regional governments, donors, and nongovernment agencies since 2006. The key outputs of the FSNWG are monthly regional food security outlooks that provide key messages and actions required by member states and agencies working in the region. The major challenge for the FSNWG is that it is not institutionalized as an IGAD coordination body. Currently, there is no regional policy mandating the preparation of hazard and vulnerability plans for the regional food and livelihood security because such a policy has not been passed by the IGAD member states.

Consistent with the vulnerability context of the Horn of Africa, the regional livestock and pastoralism coordination working group has also been established as a subgroup of the FSNWG. It aims at providing a platform for technical discussion and coordinated planning by professionals and experts dedicated to livestock and pastoralism programming in the Horn of Africa (covering seven countries: Djibouti, Ethiopia, Kenya, Somalia, South Sudan, Sudan, and Uganda).

However, although IGAD has established these working groups, the absence of a working group with a clear EWS mandate is one of the critical gaps. The role of the EWS working group would include coordination of initiatives by various organizations such as the International Maize and Wheat Improvement Center (CIMMYT)-led Integrated Agricultural Production and Food Security Forecasting System for East Africa (INAPFS) project that was launched in April 2015. Funded by the Consortium of International Agricultural Research Centers (CGIAR) Research Program on Climate Change, Agriculture and Food Security (CCAFS) under its Flagship 2 initiative, the project aims to develop a robust, scientifically sound, and user-friendly forecasting system that integrates improved seasonal climate, production, and food security forecasts for east Africa. It will also provide accurate and spatially disaggregated early warnings to local and national governments and relief agencies, enabling them to respond to climate crises in a timely and efficient manner.

In the SADC, vulnerability assessments are guided by the Regional Vulnerability Assessment Committee (RVAC) that was established in 1999. This is a multi-agency structure tasked with strengthening national and regional vulnerability analysis systems and supported by multi-agency working groups, with the following:

- Nutrition Information Management Urban Assessments IPC Centre of excellence (of five universities) and capacity building markets assessments.
- The RVAC is supported by the National Vulnerability Assessment Committees (NVACs). Although since its inception in 1999, the Vulnerability Assessment Committee (VAC) system has relied on donors and carried out as a project, the structure reviewed in 2017 shows that the VAC system is now institutionalized in the SADC structure. Although most of the countries are at different levels in terms of capacity, there is a shift toward domestic funding of the VAC process, for example, Botswana, Zambia, and South Africa generate their own funds to conduct the vulnerability assessments.
- However, about two-thirds of the participants generally disagreed on the effectiveness of the risk assessments processes and outcomes. A closer look at the thematic subjects shows that 88 percent of the participants indicated that an integrated regional food security database did not exist in each of the regions. This was confirmed through regional interviews and during the validation workshop where participants indicated that while directorates at the regional level had risk databases, they were still working in silos because there was no central portal for sharing the risk information. Some 62 percent of the participants disagreed that the risk assessment results were disaggregated according to age, gender, or disability; yet, this information is critical when targeting the at-risk population. Of all the thematic subjects, the lack of involvement of the private sector in risk assessments came under the spotlight with 93 percent of the participants indicating that the private sector was not involved in risk assessments.

3.3.2 EWS Monitoring and Warning Service at the Regional Level

A credible EWS service is supported by a sound scientific basis for predicting and forecasting hazards to generate accurate and timely warnings. The warning should be coordinated to gain the benefit of shared institutional, procedural, and communication networks.

Table 3.7 shows the proportion of responses that indicate the effectiveness of the monitoring and warning service thematic subjects on a 5-point scale. Generally, more than two-thirds (about 70 percent) of the respondents were of the impression that the monitoring and warning service was ineffective at the regional level. A closer look at the thematic subjects reveals that 80 percent felt the roles and responsibilities for agencies mandated to issue warning were unclear, because there were no regional agreements or protocols that clarify such roles. Besides, 80 percent of the participants were not aware that a regional EW committee existed. The issuance of warnings tends to be the responsibility of directorates that have mandates in those areas. For example, the Food, Agriculture, and Natural Resources directorate takes responsibility on the issuance of warnings. Although at the national level, there are established procedures, at the regional level, there are no clearly defined procedures. Developing such standards will not require considerable technical investment. Because the GHACOF and SARCOF models, for example, have a well-established system of issuing the EWs, it might be worthy building the standards using these models.

Table 3.7: Effectiveness of Monitoring and Warning Service at the Regional Level

Subjects	Frequency, percentage				
	Strongly Agree	**Agree**	**Somewhat Disagree**	**Disagree**	**Strongly Disagree**
Roles and responsibilities of agencies in generating and issuing EWs are established	7	13	7	66	7
Agreements are in place for consistency in warning language and communication channels	0	7	40	46	7
Regional EWS systems are subjected to system-wide tests and exercises annually	0	20	27	33	20
Regional EWS systems committee is in place	13	7	47	33	0
Warnings are verified to check they have reached the intended member states	0	20	40	33	7
A 24/7 regional warning center is in place and staffed	0	13	13	61	13
Equipment for hazards and vulnerability monitoring is suitable, and personnel trained in O&M	0	36	57	7	0
Hazards and food security data from regional networks and international sources are accessible (shared across boundaries)	7	33	27	33	0
Data are received and processed and warnings disseminated on time, in meaningful formats, and in real or near-real time	0	42	29	29	0
Data analysis, prediction, and warning are based on accepted scientific and technical methodologies	7	13	7	66	7
Average	**3**	**20**	**29**	**41**	**6**

Another concern expressed by about two-thirds (60 percent) of the respondents was that the EW information was rarely shared across boundaries. For example, while it is critically important to access data from the Democratic Republic of Congo for flood warning for the Zambezi river, this information is not available for countries in the Zambezi basin. Sharing information across boundaries is one of the requirements for effective monitoring of threats. The EWS for each country gives preference to the safety of its citizens. From this perspective, cross-boundary risk can receive less attention. Although some data can be accessed from satellite-based datasets, there are considerable challenges in sharing EWS information between member states. The absence of memoranda of understanding (MoUs) or a regional policy or protocol compounds the challenge. For example, Somalia heavily relies on the rivers flowing from Ethiopia. However, information on river levels in Ethiopia is rarely shared with food security analysts in Somalia; yet, this information is critical for the Somalis whose livelihoods are dependent on those rivers to act if the information is shared on time. In some cases, the information is posted online but the problem is that rural communities may not be able to access such information due to lack of Internet access and resources to purchase Internet bundles.

System-wide testing and exercises for EWSs for hazards such as drought, floods, structural failures (for example, dam failures), fire, lightning, cyclones, thunderstorms, and pest infestation should be regularly conducted. About 80 percent of the participants felt that EWSs were rarely tested at the regional level. Although some countries conduct simulation exercises, for example, Madagascar and Mozambique on cyclones and floods as well as Zambia and Zimbabwe on the Kariba Dam wall failure, the tests for fire and insect infestations such as the FAW are rare. A structured regional approach is required to enhance the capacity testing and simulation in the region. This will help expose the information and resources gaps. These weaknesses were compounded by the absence of a 24/7 regional warning center, or EOC, with about 87 percent of the participants correctly disagreeing that such a facility existed.

Effective EWSs have a feedback system to verify whether warnings have been received and acted upon. Although the risk information on health, nutrition, food availability, migration, and cross-border traders, for example, is shared through the FSNWG and RVAC bulletins, 80 percent of the participants stated that there were no regional verification systems in place to ascertain the uptake and utilization of this information. Establishing such a system might not require substantial investment for users who have access to information technology because it might involve creating an interactive platform on the website. However, for the target group, and in this case the affected communities, it might be possible to use the existing focal persons network in member states who will be requested to provide feedback to verify whether the information has been acted upon.

3.3.3 EW Information Dissemination and Communication at the Regional Level

An effective EWS depends on the robustness of the dissemination and communication system that is tailored to the needs of the users. Table 3.8 summarizes the responses on the status of dissemination and communication of regional EW information. Although about 36 percent of the participants agree that a regional system for disseminating EWS information through, for example, SARCOF, GHACOF, FSNWG, and RVAC is generally well established, about 64 percent of the participants felt that warning messages were not tailored to the needs of at-risk communities suggesting the EW information is of little use to the communities to help them make decisions.

Table 3.8: Effectiveness of EWS Dissemination and Communication at the Regional Level

Subjects	Frequency, percentage				
	Strongly Agree	**Agree**	**Somewhat Disagree**	**Disagree**	**Strongly Disagree**
EW communication and dissemination are tailored to the needs of the member states	29	7	43	14	7
Private sector resources are available where appropriate	7	7	50	29	7
Warning alerts and messages are tailored to the specific needs of those at risk	0	36	14	50	0
Average	**12**	**17**	**36**	**31**	**5**

Although the involvement of the private sector in the dissemination and communication of EWS information has come under spotlight over the years, about 86 percent of the participants stated that the private sector resources were rarely used in the dissemination and communication of warnings at the regional level. KIs revealed that where the private sector was involved, these tended to be ad hoc, with no agreements or MoUs governing such involvement.

3.3.4 Utilizing EW Information for Response Planning

The capacity to apply the EW information to preparedness and response planning is one of the indicators of an effective EWS. Using a 5-point scale, Table 3.9 presents respondents' views on the extent to which the EW information triggered regional response mechanisms. The results reveal that most (64 percent) of the participants agreed that EW data informed the regional preparedness and response plans. In the SADC region, the preseason workshops that are held before the onset of the rain season, use the data from SARCOF and RVAC to assist member states to develop contingency plans for the approaching rainy season. Similarly, in IGAD, the FSNWG issues bulletins, which assist member states to review and develop their contingency plans.

Table 3.9: Effectiveness of Response to Regional Warnings at the Regional Level

Subjects	Frequency, percentage				
	Strongly Agree	**Agree**	**Somewhat Disagree**	**Disagree**	**Strongly Disagree**
Hazard and vulnerability maps inform regional emergency preparedness and response plans	21	43	21	15	0
Regular tests and drills are conducted to test the effectiveness of EWS dissemination and responses	7	14	43	29	7
Member states respond effectively to EWs associated with all seasonal climatic hazards	0	21	36	29	14
Member states respond effectively to all EWs associated with socioeconomic hazards	7	14	43	29	7
Average	**9**	**23**	**36**	**26**	**7**

While the study found that risk data were used to develop contingency plans across the regions, the feeling by some 79 percent of the respondents is that there are no systems for simulation exercises. Particularly considering the threat of the FAW, the benefits of simulation exercises could be immense because they help in identifying gaps in preparedness and response plans, including information deficiencies, unrealistic planning assumptions and scenarios, and resource gaps. To develop such a system does not require a substantial amount of investment, because the major input is to develop the exercising materials, which can be developed with the support of cooperating partners. However, to be effective, what might be required is to develop an exercising group that will provide guidelines and schedules for such exercises.

Timely response to warnings is of essence to save lives and livelihoods. If the affected communities responded on time, it is possible to reduce the devastating impact of a materialized hazard. However, 79 percent of the participants in this study felt that the regional response was often delayed until the situation turned into an emergency. It is clear from the way the SADC responded to the 2016 El Niño-induced drought that the SADC EWS faces challenges, because this system was unable to adequately inform the SADC of the impending food insecurity. At a meeting in Johannesburg in February 2016 that was intended to produce a road map for the humanitarian appeal, most member states did not have up-to-date information. It was not until June 2017 that member states could produce the assessments results to inform the appeal that was launched in July 2016. This suggests the system is 'not well oiled' and, therefore, not as effective in providing EWS information on time. One way of prompting early action is to engage in advocacy with policy makers and senior government officials on the benefits of taking early action. This requires evidence on the costs and benefits of taking early action, which can be obtained post disaster events.

3.3.5 EWS Regional Governance Mechanisms

Well-developed governance and effective institutional arrangements support the successful development and sustainability of sound EWS systems. These should be supported by good governance, robust legal and regulatory frameworks, long-term political commitment, broader participation, and administrative and resource capabilities at the national and subnational levels. Vertical and horizontal communication and coordination between EW stakeholders should also be established (UNISDR 2006).

Table 3.10 summarizes the regional EWS institutional arrangements. Some 92 percent of study participants noted a lack of awareness of regional leaders on the benefits of investing in EWSs, while 77 percent of the participants felt that EWSs are not integrated into the regional planning process. This suggests that EWSs are perceived as a response activity rather than part of regular development processes. There was concern over unreliable and unpredictable resource mobilization from the RECs, with all the participants, both questionnaire and interviews, stating that EWSs were primarily funded by external sources, which raises questions on the sustainability of programs. Interestingly, all participants also felt that the PPPs were underutilized to help generate alternative sources of funding.

Table 3.10: Institutional Arrangements and Investment at the Regional Level

Subjects	Frequency, percentage				
	Strongly Agree	**Agree**	**Somewhat Disagree**	**Disagree**	**Strongly Disagree**
Benefits of EWS are highlighted to regional leaders	0	8	38	46	8
EWS is integrated into regional planning	0	23	62	15	0
Regional and cross-border agencies are established for EWS integration	0	8	58	34	0
Capacities of agencies are assessed and capacity-building plans developed and resourced	0	0	38	54	8
Regional funding mechanisms for EW are developed and institutionalized	0	0	46	39	15
PPPs are utilized to support the EWS system	0	0	54	23	23
Regional EWS policy is in place	13	19	56	6	6
Regional standards for EWS are in place	0	38	31	13	18
Agreements are in place for consistency in warning language and communication channels	0	7	40	47	8
Regional EWSs committee is in place	13	7	47	33	0
Warning dissemination chain is enforced through regional policy	0	21	36	36	7
Agreements are developed to utilize private sector resources in the dissemination warning	0	15	54	23	8
Average	**2**	**12**	**47**	**31**	**8**

Besides the resource challenges, the ESA region faces coordination challenges. The five RECs in ESA that are recognized by the AU are

- EAC,
- SADC,
- IGAD,
- COMESA, and
- ECCAS.

In addition, there are two RECs that are not recognized by the AU:

- SACU
- IOC

All the RECs have a focus on regional economic cooperation and integration, and considering the ESA region being agro-based, all the RECs have a remit on food security. Table 3.11 shows that most countries in the ESA region have multiple memberships to the RECs, with 11 countries being members of three RECs. This creates a situation of overlapping and in some cases competing commitments across member states, which poses challenges for members to discharge their obligations, including maintaining their membership subscriptions. A closer look at Table 3.12 reveals some duplication within the RECs on food security, but they also tend to heavily rely on external resources.

Table 3.11: ESA RECs and Their Member States Overlaps

Country	COMESA	EAC	ECCAS	IGAD	IOC	SACU	SADC
Angola	X		X				X
Botswana						X	X
Burundi	X	X	X				
Comoros	X				X		
Congo, Dem. Rep.	X		X				X
Djibouti	X			X			
Egypt	X						
Ethiopia	X						
Eretria	X			X			
Kenya	X	X		X			
Lesotho						X	X
Libya	X						
Madagascar	X				X		X
Malawi	X						
Mauritius	X				X		X
Mozambique	X						X
Namibia	X					X	X
Rwanda	X	X	X				
Seychelles	X				X		X
Somalia				X			
South Africa						X	X
South Sudan	X	X		X			
Sudan	X			X			
Swaziland	X					X	X
Tanzania		X					X
Uganda	X	X		X			
Zambia	X						X
Zimbabwe	X						X

Of the countries studied, Swaziland and Zimbabwe belong to the SADC while Djibouti, Ethiopia, Kenya, Somalia and Sudan are IGAD members.

Synthesis of data from IGAD and SADC member states reveals minimal difference. Across the board, the following are salient issues which deserve policy action at a REC level:

- Nonexistence of national standards for risk assessment
- Limited reliance on hazard and vulnerability maps in the development of national emergency preparedness and response plans.
- Non-existence of regular public awareness /education campaigns concerning disaster risks

- Limited consultation of affected communities and industries while conducting risk assessment.
- Absence of binding agreements for consistency in warning language and communication channels.
- Failure to tailor warning alerts and messages to the specific needs of those at risk and incorporate the understanding of the values, concerns and interests of those who will need to take action.

This means challenges to EWSs across the African continent are similar with scattered best practice information – thus, the need to encourage and support knowledge and experience sharing between and among countries irrespective of REC membership.

Table 3.12: Regional EWS Institutional Summary

Region	Agency/System	Roles and Responsibilities	Products and Services	Weaknesses
SADC	CSC	Provides operational services for monitoring and predicting climate extremes	Weather/climate forecasts, including SARCOF and capacity building	Technical capacity and resources
	Food Security Information System	Regional Early Warning System provides advance information on food crop yields and food supplies and requirements.	Food security bulletins, seasonal outlooks, and monthly regional balance sheet	Technical capacity, external resources, and diverse methodologies
		RVAA	Humanitarian situation, RFBS, and food insecure population	Technical capacity, resources, and multiple methodologies
	DRR Unit	Develops regional DRR strategies and facilitates preseason preparedness plans and postseason lessons learning	DRR strategies, including regional preparedness and response strategies	Limited technical capacity and reliance on external resources
	Regional Early Warning Centre	Strengthen the SADC mechanisms for conflict prevention, management, and resolution	Security information and inputs to RVAA program	No clear integration to food security
IGAD	ICPAC	Climate monitoring, prediction, applications, capacity building, environmental monitoring, DRR, dissemination, and research	Dekadal (10 day) and monthly bulletins, seasonal outlooks including GHACOF, and climate watch	Reliance on external funding
	Conflict Early Warning and Response Mechanism	Assess situations that could potentially lead to violence or conflicts and prevent escalation	Linking conflict and food security and EWSs by considering ICPAC climatic forecast	Weak link with food security EWS and reliance on external resources
	Center for Pastoral Areas and Livestock Development	Regional livestock and dry-lands policy, research and development, coordination, and capacity building	Transboundary animal disease control, livestock products trade, and mapping cross-border resources	Reliance on external funding
	FSNWG	Up-to-date food security and nutrition analysis and building of consensus on critical issues facing policy and intervention	Monthly regional food security and nutrition outlook through email and posted online	External resources and not institutionalized in IGAD structure
EAC	Agriculture and Food Security	Improve food security, strengthen the EWS, and increase inter/intra-regional trade	RFBS, cross-border trade monitoring, and EAGC bulletin	Policy, technical capacity, and multiple membership
COMESA	Climate Change Unit	Address the impacts of climate change in the COMESA-EAC-SADC region and promote climate-smart agriculture	Updates on the COMESA-EAC-SADC tripartite arrangements	Reliance on external funding, coordination between the RECs, and multiple membership
	Food and Agricultural Marketing Information System (FAMIS)	Improve agricultural marketing through the dissemination of market information, policy changes, and impacts	Information portal and cellular-based information platform to inform conservation agriculture, weather, and agro-dealers	Reliance on external funding, coordination between the RECs, and multiple membership

CHAPTER FOUR: STRATEGIES FOR LONG_TERM SUSTAINABILITY OF INVESTMENTS ON EARLY WARNING SYSTEMS

4.1 Introduction

Documenting the value of hydrometeorological services helps to justify investment in NMHSs as well as those agencies tasked with vulnerability assessments and monitoring. It is particularly important to consider that that over 100 NMHSs in developing countries need substantial investment to bring their services to a level at which they can provide timely, reliable, and accurate forecasts of high-impact weather to the public and to national economic sectors (Rogers and Tsirkunov 2013). This chapter highlights some of the investment required to strengthen an EWS. The chapter begins by a reflection on the cost-benefit analysis of investing in EWSs. The costs are estimates based on other studies and field consultations. It is important to highlight that only a few comprehensive studies on the Benefit-Cost Ratio (BCR) have been carried out in developing countries. Some of the costing presented in this chapter has not been subjected to rigorous costs-benefit analyses to determine the BCR and the economic rate of return to such investments.

4.2 The Costs and Benefits of Investing in an EWS

While there is a widespread recognition on the need to improve countries' capacity to prepare and respond to evolving and future food insecurity crises, As the data suggest in Chapter Three, there is still a challenge investing in food security EWSs in the ESA region. Part of the problem is lack of studies that demonstrate the benefits of such investments. Most of the studies that have been conducted have tended to be focused toward assessing the benefits of investing in agrometeorological services. There is still a high level of compartmentalization in the analyses that hinder the ability to integrate the entire food security and EW information system, considering all the components of effective end-to-end EWS, that include physical climate hazard and social vulnerability dimensions. However, even without a comprehensive analysis of costs and benefits of the entire information system, the studies on weather and climate services are overwhelmingly positive and suggest the triple bottom line benefits of investing in NMHSs (Box 4.1). The BCRs as illustrated in Table 4.1 range from 2:1 to 36:1, and in one study, in which the value of lives was quantified, a BCR of 2,000:1 was estimated.

In developing countries, which include the ESA countries, the benefits, on average, range from 4:1 to 36:1, for example in Nepal (10:1) and Ethiopia (3:1 to 6:1). There is, however, a need for caution when analyzing the World Bank projects in Sub-Saharan Africa in Table 4.2 which have a strong element on food security and EW information systems. While the range of BCRs appears to be at the lower end of the average of developing countries, however, if the wider social benefits were included in the cost-benefit analyses, in addition to the direct quantifiable benefits, the benefits are much higher.

Table 4.1: Examples of Triple Bottom Benefits of Investing in Hydrometeorological Services

Theme	Benefits
Social	Avoidance of loss of life and/or injuries/illnesses from natural disasters Safety and security of the travelling public - improved information and data to the scientific community Contribution to the day-to-day safety, comfort, enjoyment, and general convenience of citizens, including: Recreation Travel and commuting Preparation for severe weather Home improvement decisions Other direct and indirect forms of societal benefits Event management Avoided climate-related illnesses (for example, heat-related illnesses, vector-borne diseases such as malaria that are worsened by climate)
Environmental	Long-term monitoring of basic indicators of the state of the environment Minimization of release of toxic substances and other pollutants Management of local environmental quality Support for addressing major global environmental issues Water savings Reduced runoff from fertilizer application, resulting in improved water quality
Economic	Avoidance of crop losses from frost, hail, or drought Increased farm production and sales More efficient scheduling of the use of agricultural machinery Reduced transportation fuel consumption through route planning Improved scheduling of flight arrivals and departures Minimization of airline costs from aircraft diversions Minimization of search and rescue costs Minimization of drought-relief costs Efficient scheduling of ship loading facilities Avoidance of unnecessary shutdown of offshore oil and gas operations Avoidance of weather damage to personal property More efficient planning of energy production and delivery

Source: Lazo et al. 2009, cited in WMO 2015, 60.

Table 4.2: Illustrative Economic Assessments of Meteorological/Hydrometeorological services

Social Economic Benefits Study	Geographical Location	Sectors	Benefits Methods/Measures	BCR
Contingent valuation study of the public weather service in the Sydney metropolitan area (Anaman et al. 1998).	Sydney, Australia	Households	Willingness to pay (WTP) survey of households	4:1
Benefits of Ethiopia's Livelihoods, Early Assessment, and Protection (LEAP) drought early warning and response system (Law 2012)	Ethiopia	Households	Quantification of avoided livelihood losses and decreased assistance costs	3:1 to 6:1
Success of the United States National Weather Service (NWS) Heat Watch/Warning System in Philadelphia (Ebi et al. 2004)	Philadelphia, Pennsylvania, United States of America	Households/elderly	Regression analysis to determine lives saved, application of the United States Environmental Protection Agency (EPA) value of a statistical life (VSL) estimate	2000:1+
The benefits to Mexican agriculture of an El Niño - Southern Oscillation (ENSO) early warning system (Adams et al. 2003)	Five-state region in Mexico	Agriculture	Change in social welfare based on increased crop production with use of improved information	2:1 to 9:1
Economic efficiency of NMHS modernization in Europe and Central Asia (World Bank 2008)	11 European and Central Asian countries	Weather-dependent sectors	Sector-specific and benchmarking approaches to evaluate avoided losses	2:1 to 14:1
Benefits and costs of improving met/hydro services in developing countries (Hallegatte 2012)	Developing countries	National level and weather-sensitive sectors	Benefits-transfer approach to quantify avoided asset losses, lives saved, and total value added in weather-sensitive sectors	4:1 to 36:1
Social economic benefits of enhanced weather services in Nepal – part of the Finnish-Nepalese project (Perrels 2011)	Nepal	Agriculture, transport, and hydropower	Statistical inference and expert judgment	10:1
Economic and social benefits of meteorology and climatology (Frei 2010)	Switzerland	Transport, energy, aviation, agriculture, and households	Benefit transfer, expert elicitation, decision modeling	5:1 to 10:1
Socioeconomic evaluation of improved met/hydro services in Bhutan (Pilli-Sihvola et al. 2014)	Bhutan	National level	Benefit transfer, expert elicitation, cardinal rating method	3:1

Source: Adapted from WMO 2015, 8–9.

Table 4.3: Benefits of Investing in Climate Information and EWSs

Country	Name of Project	Project Duration	Investment (US$, millions)	Net Present Value (NPV)		BCR
				US$, millions	Discount Rate (percent)	
Kenya[a]	Kenya Climate-Smart Agriculture Project with a component on Supporting Agro-weather, Market, Climate and Advisory Services	2017–2022	279	304	6	1.40–5.56
Mozambique[b]	Mozambique Climate Resilience: Transforming Hydrological and Meteorological Services	2013–2018	22.50	391.17	3	6.56
Democratic Republic of Congo[c]	Strengthening Hydro-Meteorological and Climate Services	2017–2022	8.029	117.27	3	2.39—7.36
Mali[d]	Strengthening Climate Resilience in Sub-Saharan Africa: Phase 1 Mali Country	Feasibility study	22.75	124.4	5	5
Madagascar	National Action Plan for Improvement of Hydrometeorological Services	Feasibility study	58.48	44.9	3	1.67—7.60
Nigeria	Transforming Irrigation Management in Nigeria	2014–2022	560.3	12	13.5	Not stated
Zambia	Zambia Strengthening Climate Resilience (PPCR Phase II)	2013–2019	36	18.3	3	Not stated
Tanzania	Second Water Sector Support	2017–2021	230	180	10	Not stated
Uganda	Water Management and Development	2012–2018	135	24.6	15	Not stated

Note:
a. This includes US$32.9 for the development of agro-weather forecasting and marketing information system and their dissemination tools through improving agrometeorological forecasting and monitoring institutional and technical capacity; using big data to develop a climate-smart, agro-weather MIS and advisories. The Project Appraisal Documents (PADs) can be accessed at http://documents.worldbank.org/curated/en/440241486868444705/pdf/Kenya-PAD-01182017.pdf.
[b]. The PAD can be accessed at http://documents.worldbank.org/curated/en/506641468321881521/pdf/759390PAD0P1310040901300SIMULT0DISC.pdf.
c. The analysis follows the overall structure of the 'Triple Dividend of Resilience' framework, which includes (a) avoided damage and losses, (b) unlocked economic potential, and (c) development co-benefits. The PADs can be accessed at http://documents.worldbank.org/curated/en/289901488209393335/pdf/DRC-GEF-PAD-02222017.pdf.
d. See http://www.greenclimate.fund/documents/20182/226888/GCF_B.13_16_Add.04_-_Funding_proposal_package_for_FP012.pdf/2af42103-a150-4e0b-a3f3-29d8b433e377.

Box 4.1: Benefits of Early Action

A study by the U.K. Department for International Development that examined the relative costs of early and late action for drought in Kenya and Ethiopia suggests that the economic case for early action is compelling. Over a 20-year period of droughts on a 5-year cycle, it was estimated that early procurement by agencies and early interventions to support pastoralist livelihoods such as commercial destocking, supplementary animal feeding, and veterinary services could generate significant savings relative to an emergency response. In the Wajir district of Kenya these were estimated to be US$392 million, and in the more populous region of Southern Ethiopia it was US$3,066 million: over US$1,000 per beneficiary in each case (table below)

Table 4.4: Cost Estimates for Drought Responses in Horn of Africa, Discounted over 20 years

	Beneficiaries	Emergency	Early Action	Saving	Saving Per Capita
Wajir, Kenya	367,000	US$606 million	US$214 million	US$392 million	US$1,068
Southern Ethiopia	2,800,000	US$3,800 million	US$734 million	US$3,066 million	US$1,095

Source: Bailey 2012, 6.

Similarly, the BCR of improving national hydrometeorological services in developing countries ranges from 4:1 to 36:1. In Ethiopia, a drought EWS can potentially reduce livelihood losses and dependence on assistance, with a BCR ranging from 3:1 to 6:1 (WMO 2015).

There are several examples of the benefits of investing in EWSs. In the Democratic Republic of Congo, the World Bank is supporting a project entitled ‘Strengthening Hydro-Meteorological and Climate Services’. The aim of the project is to improve the quality of the Government of the Democratic Republic of Congo’s targeted hydrometeorological and climate service by:

- Improving hydrometeorological and EW capacity and strengthening networks through open data and information sharing;
- Leveraging partnerships and fostering interagency coordination to maximize economies of scale and regional integration and promote south-south cooperation to ensure transformational change and longer-term sustainability;
- Aligning with the principles of the Global Framework for Climate Services (GFCS) and identifying the requirements of users as a starting point for generation of services, products, and data.

The costs associated with the project amount to a total of about US$8 million (Table 4.3) with an estimated NPV[24] of US$112.27 million and with a BCR of 7.36: 1 at 3 percent baseline discount rate.[25] Based on the ‘Triple Dividend of Resilience’ framework, the benefits will include (a) avoided damage and losses, (b) unlocked economic potential, and (c) development co-benefits.

[24] **‘Net present value’** is the present value of a security or an investment project, found by discounting all present and future receipts and outgoings at an appropriate rate of discount (see discount rate). If the NPV calculated is positive, it is worthwhile investing in a project (Black et al. 2017).
[25] **‘Discount rate’** is the interest rate at which future benefits or costs are discounted to find their present value (Black et al. 2017).

Table 4.5: Financing for Strengthening Hydrometeorological and Climate Services in the Democratic Republic of Congo

Component, Subcomponent, and Indicative Budget (US$)	Total (US$)
Component A - Institutional and regulatory strengthening, capacity building, and implementation support	**1,578,000**
A (i) Reinforce the legal and regulatory framework of MettelSat to develop partnerships and SOPs for delivery of service	
A (ii) Strengthen the quality management systems to raise standards and quality control/verification procedures across the institutions	
A (iii) Implement a long-term and on-demand capacity development and training program for staff	
Component B - Modernization of equipment, facilities, and infrastructure for basic observation and forecasting	**4,462,000**
B (i) Hydrological and meteorological monitoring networks (small-scale rehabilitation of priority stations and installation of new sensors)	
B (ii) Transmission, data management, and data dissemination hardware	
B (iii) Refurbishment of facilities needed to support the services	
B (iv) Technical systems and software for performing meteorological, hydrological, and climate modeling, and forecasting	
Component C - Improvement of hydromet information service delivery	**1,256,000**
C (i) Define requirements, delivery, and feedback mechanisms with different user groups (in line with the National Framework for Climate Services)	
C (ii) Develop customized products and services made available to user groups through dedicated interfaces	
Component D - Project management	**733,452**
D (i) Coordination and technical implementation support	
D (ii) Fiduciary and safeguard aspects and audit	
Total	**8,029,452**

Source: PAD for Financing for Strengthening Hydro-meteorological and Climate Services in the Democratic Republic of Congo. Report No: PAD1864

While the Democratic Republic of Congo project identifies the importance of legal and regulatory frameworks and gender awareness, it does not have a strong institutional capacity building component at the subnational level, which participants of this study called "the more encompassing and proactive food information approach which addresses all components of food security in line with its definition. However, it is important to emphasize and recognize that the project's main objective was not necessarily on addressing food security risks. The objective is directly aimed at hydromet modernization, which has direct, measurable impacts on improving the country's capacity to provide enhanced agro-met services, and in turn, improving agricultural extension services.

It is widely recognized that enhancing the knowledge on hydromet hazards is key for improving the effectiveness of multi-hazard EWS. However, While the significance of meteorological data/information in food security information cannot be underestimated, it just remains to be one of many other data/information types of food security. Hence, there is a need to pay due attention to the other data types and sources."[26] The examples from Madagascar (Table 4.6) and Zambia (Table 4.7) are more reflective of the comprehensive investment needs of most ESA countries as they address both the technical and the institutional needs at both national and subnational levels.

[26] One of the participants consulted as part of this study.

Table 4.6: Estimated Costs for National Action Plan for Improvement of Hydrometeorological Services (NAPIHMS) Project in Madagascar (US$)

	Phase 1 (Years 1–2)	Phase 2 (Years 3–5)	Phase 3 (Years 6–10)	O&M (Years 11–15)	Totals
Monitoring Network Equipment					**25,785,402**
Hydrological observation network	531,250	1,593,750	3,187,500		5,312,500
Groundwater observation network		403,200	604,800		1,008,000
Meteorological and climatological observation network	263,135	726,405	1,011,810		2,001,350
Radar		6,000,000	6,000,000		12,000,000
Volunteer rainfall network	3,305	9,915	19,830		33,050
Vehicles	96,000	288,000	576,000		960,000
Water quality lab equipment	26,600	79,801	159,601		266,002
Discharge measurement equipment	63,000	189,000	378,000		630,000
Field equipment	215,625	646,875	1,293,750		2,156,250
Data management	2,715	8,145	16,290		27,150
Rehabilitation of the DGM hydrometeorological instrumentation laboratory.	150,000				150,000
Installation of new hydrometeorological stations	111,510	384,930	744,660		1,241,100
Forecasting and Service Delivery					**5,065,285**
Headquarters and regional hydrological forecasting center O&M	72,000	781,714	1,508,571	1,560,000	3,922,285
Headquarters and regional hydrological forecasting center capital investment	207,000	346,000	185,000	155,000	893,000
Weather forecasting equipment and software	150,000	50,00	50,000		250,000
O&M					**18,335,633**
Monitoring network	582,369	2,362,314	7,494,225	7,494,225	17,933,133
Stations rehabilitation works	11,250	26,250			37,500
Stations rehabilitation equipment	109,500	255,500			365,000
Research and development		992,008	1,488,012		**2,480,020**
Training and capacity development	222,300	666,900	1,333,800		**2,223,000**
NMHSUG training	100,000	100,000			**200,000**
Consulting	1,760,000	1,320,000	1,320,000		**4,400,000**
Total by phase:	4,677,559	17,180,707	27,371,849	9,209,225	
				Grand Total:	**58,489,340**

Note: The costings are based on the NAPIHMS World Bank project in Madagascar

Table 4.7: Estimated Costs of the Food Security EWS in Zambia

Sector	Capacity Needs	Cost (US$)
ZMD	Equipment (AWSs, radars, computers, software, and so on)	13,080,000
	Technical capacity (training for staff)	2,250,000
	Institutional capacity (training, AWSs/radars O&M, and so on)	35,000
	Subtotal	**15,365,000**
Hydrological Services	Equipment (telemetric stations, computers, and so on)	7,553,150
	Technical capacity (human resources capacity building)	935,000
	Institutional capacity (training catchment councils, and so on)	3,340,000
	Subtotal	**11,828,150**
Agriculture	Equipment (increasing rain gauge network)	180,000
	Technical capacity (capacity for data analysts)	20,000
	Institutional capacity (capacity for extension services)	50,000
	Subtotal	**250,000**
DMMU	Technical capacity (national level) (information system set-up)	1,089,000
	Institutional capacity (national level)	1,598,050
	Provincial-level capacity building	559,000
	District-level capacity building	19,527,500
	Satellite-level capacity building	36,380,000
	Subtotal	**59,153,550**
Grand total		**86,596,700**

Note: a. The cost estimated were produced by the DMMU, with inputs from Zambia Meteorological Services, Hydrology, and Agriculture.

However, the estimated investments are beyond the capacity of most ESA countries. A phased approach might be required. A study conducted by the World Bank (2015) illustrates three investment options on a continuum, from traditional to advanced weather station program (Table 4.8), with each option having a high BCR. This suggests that even when a phased approach is considered, the benefits accruing from the investment are still high.

Table 4.8: Options for Investing in Observation Networks

Option	Traditional/Minimal	Transitional	Modern/Advanced
Description	Mostly traditional instrumentation, with automated systems at only a very limited number of locations; limited professional agrometeorological staff, very limited field training or extension work; no real-time operations	Still mostly traditional instrumentation, but more automated systems in regional networks; staff of agrometeorologists and supporting technicians still modest in size but now sufficiently large to begin routine training of farmers and support	National network of automated systems supplemented by traditional instrumentation, professional staff now able to support full-scale real-time operations and fieldwork for training and extension support
Initial capital investment in equipment, facilities, training	US$3 million	US$20 million	US$50 million
Continuing annual cost	US$1 million	US$5 million	US$10 million
Cost-benefit ratio	1:30 - US$30 million increase in agricultural production	approximately 1:50 - US$250 million increase in agricultural production	1:100 - US$1 billion increase in agricultural production

The same study applies the results to Ethiopia and Kenya, which may also apply widely to most ESA countries. In Ethiopia, agriculture accounts for about 39.4 percent of the national gross domestic product (GDP) = US$41.72 billion (2012 estimate or about US$16.44 billion). If a traditional or minimal agrometeorology program is considered, it would increase the agricultural contribution to GDP by about 0.18 percent, a transitional program by about 1.5 percent, and a modern or advanced program by about 6.1 percent. Similarly, in Kenya, agriculture accounts for about 24 percent of the national GDP of US$40.70 billion (2012 estimate or US$10 billion). If a traditional or minimal agrometeorology program is considered, this would increase the agricultural contribution to GDP by about 0.30 percent, a transitional program by about 2.5 percent, and a modern or advanced program by about 10 percent. The comments arising from this are as follows:

- Clearly, as one progresses from a traditional to advanced program, the contribution to the GDP increases. When weighing the impact of investments that increase the contribution of agriculture to the GDP, and consequently to poverty reduction, –as a large share of many African countries' households are engaged in agricultural activities. In Uganda, for instance, the remarkable decrease in poverty levels is directly attributable to increases in the contribution of agriculture to the GDP.
- A traditional or minimal program is consistent with the current investment levels in most ESA countries and such a program does not contribute much to the national GDP. The resources could be deployed elsewhere where they can yield better benefits.
- Although the advanced program has the potential of delivering increased economic benefits, policy makers may not support the investment required. This will need evidence-based advocacy through contextualized EWS cost-benefit studies.

According to the findings of this study, upgrading the observation networks alone is inadequate for achieving the goals of measurably reducing the levels of poverty and food insecurity across the

ESA regions. But, it is a required ingredient in the establishment of effective and efficient end-to-end EWSs, including those for food security.. This means a phased strategy is required to incrementally build on the successes of each of the phases. A strategy that works in partnership with the private sector and farmers' union might be required to leverage on the resources.

Governments in Africa should commit to and take responsibility for the adequate funding of the NMHSs as basic hydromet monitoring and forecasting services shall be provided as a public good. Strong NMHS can develop additional sources of funding, through the provision of specialized services to sectors and industries, such as aviation and insurance, but the societal benefits of the provision of basic hydromet services at-no cost to all audiences surpass the direct costs to the government. Governments should ensure that NMHSs are able to discharge their institutional responsibilities in an adequate and sustainable manner. As part of the strengthening of the NMHs and the services they provide, exploring win-win NMHS-led partnerships with the private sector should also be encouraged.

4.3 Cost-Effective Strategies for Improving Agrometeorological Observation Systems

One of the key findings of this study is that most ESA countries have some system for hydrometeorological observation services. Many countries have both the traditional observation networks, which employ observers or local volunteers, with only modest training and AWSs. There are two strategic options for improving the weather observation networks, and ultimately the quality and types of agrometeorological services that can be provided to targeted audiences. First, is to enhance the existing manual weather stations and the second is to migrate incrementally to a modern and advanced observation network.

Option 1: Enhancing the manual weather stations

Most meteorological and hydrololgical observation networks in the ESA countries are manual weather stations. While it is recognized that not all the instrumentation or methods used for hydromet monitoring and forecasting are used for/ or applicable to agrometeorology (e.g. lake and maritime navigation), adequate coverage of the observational networks contributes to improve countries' capacity to provide adequate, timely agrometeorological to agriculturists, pastoralists and other audiences involved in weather- and climate-sensitive sectors.

In Ethiopia, for example, there are several hundreds of manual weather stations, a similar situation across the ESA countries. In most cases, the observations from manual networks are recorded by hand and often mailed into a central office. Such observations, when passed by a rigorous quality assurance process, provide invaluable data for both long-term climate studies and monitoring of how given growing seasons are evolving.

Equipment such as rain gauges can be locally fabricated and such weather stations can be placed in schools and rural health centers. A simple datasheet is recorded by hand, as is the case in Zambia's Sesheke weather station, after which the data is transmitted by a mobile phone or mailed to a central location. The data transmitted through the mobile phone go to an automated receiving system that records the data, does simple error checking, and provides a first-order analysis. While manual weather stations have several disadvantages, such as data inaccuracies and slowness in data collection and transmission, the manual weather stations tend to have relatively low O&M costs.

It has been well documented that in the medium- to long-term, O&M of hydromet monitoring and forecasting represent the highest cost items of any investments in hydromet modernization, surpassing the original costs of upgrading equipment and software. Such high costs of O&M are the primary reason why so many good intentioned equipment improvement projects failed when the funding ended.

The application of mobile technologies, as is the case at Sesheke weather station in Western Zambia, facilitates the transmission of near real-time data to Lusaka three times per day. Using mobile phone technology enables fast data aggregation and calculation of temperature and precipitation data. In Sesheke, mobile phones are also used to share weather data with local farmers, for example through WhatsApp groups and community radio stations.

The estimated cost of upgrading a manual station to use mobile phone technology in data collection and transmission in Zambia is about US$75,000 which is consistent with the World Bank (2015) study that estimated the costs between US$50,000 to US$75,000 to install the central data collection computer.

There will be deployment and training costs to get the new equipment into the field and to train the observers or volunteers to operate it. Upgrading a manual weather station, as is the case with Sesheke, comes with continuing charges for the mobile phone services and maintenance of the central computer. However, if mobile phones charges are unbearable, the observers switch to pen and paper format. In any case, in Sesheke for example, in addition to the data recorded in a mobile phone, a manual copy is also maintained as a backup. The study by the World Bank (2015) reiterates the importance of training the operators at the central computer to a higher skill level in programming and system administration. Additional personnel should include a small team of three or more quality assurance meteorologists who review the raw data in parallel with the automated procedures, flagging questionable data.

Option 2: Transition to modern and advanced networks

There are several different costs involved in developing a national meteorological observation system. The study by the World Bank (2015) categorizes the costs that may be involved in investing in advanced observation networks. These are summarized in Table 4.9.

Table 4.9: Estimated Annual Costs of an Advanced Network

Element	Description	Estimated cost (US$)
Site costs	Purchase or long-term lease of the site; civil works and site preparations as needed (access road, security fence, electrical power if available or a solar panel/battery system—the last one is a good backup against outages even if electrical power is available); tower or mast; instrumentation; data logger and software; telecom interface (could be microwave radio, cell phone connection, hardwired Internet connection, and so on; can be two-way to allow remote interrogation of the data logger); cables and related hardware; labor for site improvements, installation, and so on; miscellaneous costs such as shipping costs related to getting equipment on site. Costs can run between US$10,000 and US$100,000 per site, depending on the number and types of instruments installed. A good mean cost would be US$55,000.	55,000
Central data collection facility costs	Facility preparation (space modifications, provision of power, provision for air conditioning, dehumidification, heating as necessary); telecom interface for receiving incoming data streams (and transmitting commands to data loggers in the field); computer(s) for receiving, decoding, quality checking, and basic analysis (this could be the same system that receives data from the traditional network); display system. Can run between US$50,000 and US$350,000 (average = US$225,0000).	225,000
Central maintenance facility	Facility preparation (space modifications, provision of power, provision for air conditioning, dehumidification, heating as necessary); facility furnishings to include workspace for maintenance and calibration, and storage space for spare instruments, repair parts, and expendables; tools and calibration equipment; miscellaneous costs such as shipping costs. Costs can run between US$50 and US$250,000.	150,000
Staff costs	Data analysts, software developers, technical maintenance/calibration staff - about 8 to 10 professionals required at US$15,000 per year = US$120,000–US$150,000.	130,000
Operating costs	Telecom charges; repair parts and spare instruments; expendable supplies for operating and maintaining the data collection system; vehicles, fuel, and the related (a small group of vehicles are needed for all agrometeorologists to go out in the field to study local conditions and to support technical maintenance/calibration staff making routine site visits) Costs can run between US$25,000 per year and US$250,000 per year.	140,000
Total	**Approximately US$1 million**	**700,000**

The study by the World Bank (2015) also suggests the steps to be followed for the strategy to be cost-effective.

Step 1a. In parallel, build up and enhance the existing traditional network of rain and temperature observations taken by observers and volunteers. Where the cell network allows, provide observers with mobile phones to call in their observations once per day.

Step 1b In parallel, establish an automated dial-in data delivery system so that people can begin sending information. This computer should have sufficient capability to service both the dial-in delivery of data from network of traditional sites, data from manual weather stations received through mail, and the acquisition of data from the modern or advanced sites. This means the central data collection goes in at this early stage, so that it is ready to receive data from the AWSs (as well as from the enhanced traditional network).

Step 2. Select sites for the installation of the AWSs supporting agrometeorology. Keep in mind that this is an agrometeorology network, so the stations will be concentrated in agricultural regions with sites selected to be representative of local farming operations. Ideally sites would be within, but distinct from, fields. However, this is not always practical, so sites at the edge of fields may be utilized.

The program can start from a few stations and then gradually upscale to cover the whole country.

4.4 Strengthening Food Security Information Systems at Regional Level

At the regional level, there are efforts in developing the EWS information systems, which include food security. Presently, the RECs have multiple information systems and networks, some of which have continental and international standing. ICPAC and CEWARN in IGAD and the VAA, CSC, and Regional Early Warning Center EW in the SADC are exemplary of successful information networks. Most of the other systems are either in their infancy or limited to specific programs. For these systems to be effective, they require policy, legal, institutional, operational mechanisms in place for coordinating, streamlining, and harmonizing the activities of these systems to optimize their performance efficiently and effectively. Inevitably, disparities exist in data and information exchange systems and processes among these networks, which lead to duplication of efforts, wastage of resources, and even to undesirable competition.

In the SADC, the DRR Unit is in the process of developing a disaster management information system portal that will be accessible to users. The need to strengthen the information system has also been expressed in the SADC's 2017 Regional Disaster Preparedness and Response Strategy. In East Africa, the EAC is working on an initiative to develop climate information sharing, and so is the COMESA. In IGAD, there are efforts to revamp the Regional Integrated Information System (RIIS). Because the major role of the RECs is mainly to integrate national information systems into a coordinated regional information system, the investment is modest. A good example is IGAD's proposed RIIS whose estimated costs are provided in Table 4.10.

Table 4.10: IGAD RIIS - Estimated Budget for the Formulation Process of the RIIS

Phase	Description	Cost (US$)
Phase 1	**Assessment of Information System in the IGAD Region**	
Consultants	Fees and local transport for seven National consultants (1 per member state) for two weeks	17,500
	Total fees for two International consultants for 30 days	39,000
	Travels	11,000
Workshops	Seven national workshops (1 per member state)	49,000
	One regional workshop to review assessment findings	100,000
Phase 2	**Design/Architecture of the RIIS**	
Consultants	Fees for two international consultants	19,500
Workshops	One regional workshop to review the RIIS design	100,000
Phase 3	**Formulation of the RIIS Project Document**	
Consultants	Fees for two international consultants	39,000
Workshops	One regional workshop to validate the RIIS project document	100,000
	Total	**475,000**
	Contingency	**25,000**

Phase	Description	Cost (US$)
	Total	**500,000**

Table 4.11 assumes that the member states will meet the operating costs during and after project implementation to sustain project benefits. As emphasized by participants at the validation workshop as part of this exercise, in addition to member states mobilizing resources internally, support from cooperating partners and PPPs would be required.

Table 4.11: Roles of Regional and National Funding Mechanisms

Regional Mechanisms	National Mechanisms
Member states should provide funding for EWS programs Mechanisms should be developed to address transboundary issues Centers of leadership for example, downscaling global models to national levels; and capacity development should be developed Funding policies for EWS should be developed, harmonized with existing policies and effectively implemented Develop policies/protocols for data sharing Instances where economies of scale would benefit from regional funding mechanisms should be prioritized	PPPs should be developed as one of the key priorities for sustainable EWSs, for example, the PPPs can build on existing partnerships with telecom service providers to provide the EW information to their subscribers for free like in Zimbabwe. Government to create the EW units for governance, policy and strategy, coordinating agency for national EWS funding mechanisms

Source: Validation workshop.

4.5 Operational Models and PPPs

Generally understood as a 'long-term contract between a private party and a government agency, for providing a public asset or service, in which the private party bears significant risk and management responsibility' (World Bank 2012, 11), PPPs are more than just an interesting idea; they are a necessity in the provision of climate services (Snow et al. 2016).
The widely held idea that specialized government agencies (NMHSs) have the authority and responsibility for the provision of hydromet forecasting and monitoring services as a government -financed public good is exemplified by the role played by leading meteorological agencies of the US and Europe that provide their basic services at-no-cost to everyone, including the private sector. This proposition is supported by the accounting of tangible benefits, including the financial returns from revenue collected by the governments from private companies' development and marketing of derivative products and services based on "free" hydromet information. In addition, indirect financial gains for the government include the reduction of its contingent liabilities from losses derived from uninsured assets, as readily available basic hydrometeorlogical information, allows and promotes the development new industries such as insurance markets for weather- and climate-related perils such as flood risk and crop failure, which in their absence would compel the government to intervene as the insurer of last resort to compensate uninsured victims.

In this context, there are several reasons for involving private sector in climate and weather information provision. For instance, private sector enterprises can leverage technical and financial resources for addressing evolving information needs, such as the increasing demand for localized weather information, e.g. by large agribusinesses; allowing the NMHSs to focus on improving their country-level monitoring and forecasting capabilities, as well as providing entirely new services. Thus:

- Leveraging on private sector capacity, NMHSs may increase the sustainability of the benefits of the climate and weather information services. The increasing access to the internet provides an opportunity for research institutions, businesses, and individuals to generate weather data using freely available satellite data and by purchasing their own weather stations.
- Mutually beneficial collaborative arrangements can be established among the NMHSs and the academic and research institutions as well as with the private sector aimed at expanding the types and quality of weather and climate information and services that can be provided to general public as well as to specialized audiences.

There are several PPP operational models. Although Snow et al. (2016) identify four PPP models on a continuum, the 5 business operating models that are relevant to the ESA countries are those identified by the World Bank (2016) (Box 4.2).

Box 4.2: Operating Models of Climate Information Services Providers

Table 4.12: Operating Models

Characteristics	Operating models				
	Public departmental unit	**Public body**	**Private but not profit oriented**	**Private and profit-oriented**	**International organization**
Government control	Directly controlled	Indirectly controlled	Indirectly controlled	Indirectly controlled	No, Host country agreements
Own legal entity	No	Partially or fully separate	Yes	Yes	Yes
Legal basis	Public law	Public law	Private law	Private law	Convention
Financing	State budget, grants	State budget, grants, own revenues	Grants, own revenues	Own revenues	Grants
Control mechanism	Direct political	Statutes, laws	Regulation	Regulation	Host country agreements
Ministerial responsibility	Yes	Partial	No	No	No
Autonomy	No	Yes	Yes	Yes	Yes

Each of these models is characterized by the following:

Public departmental unit. This model is characterized by lack of autonomy, finance by state budget, problem of monopoly, limited and unreliable public financing, weak technical capacity, low organization incentives, little freedom or incentive to compete in commercial markets, and poor service delivery.

Public body. This model faces less political and hierarchical influence, has more operational and managerial freedom, supplements state budgets with grants and revenue from service delivery, faces challenges in enforcing payments for services from sister departments.

Private but not profit oriented. These are climate adaptation projects and project-based sponsorship, targeting limited number of beneficiaries, with limited scope of service provision, and are unsustainable.

Privatized companies. Operate in free market, generate own revenue, enjoy high freedom of autonomy, subject to government regulations. Privatization may not offer a solution to effective climate information service delivery.

International organizations. Funding from members and grants, do not generate revenue from climate services.

Source: World Bank Group 2016.

There is potential for PPPs in the ESA countries (Table 4.12) to generate revenue from the sale of weather/climate goods and services to the private sector. This potential is a result of a positive enabling environment for PPPs, as well as effective communication channels to disseminate information. The capacities for NMHSs to engage in PPPs vary across the ESA region, with

Tanzania and Zambia being at the level where they can start engaging in PPPs compared with the NMHSs in Uganda, Malawi, and Ethiopia where the following challenges are more pronounced:

- Limited technical capacity to generate tailored products and services to meet the specific needs of private sector clients.
- Limited funding from their governments.
- Weak network of weather observation stations to generate fine-scale weather data.
- Inadequate political framework for regulating PPPs.

During this study, KIs expressed concerns regarding the privatization of climate services; particularly on the risk of further marginalizing vulnerable communities who are unable or unwilling to pay for the climate services that are unaffordable to them. In this regard, There is a need for further explore communities' willingness to pay for specialized climate services across the ESA countriesTable 4.133: Potential for NMHSs to Develop PPPs in Weather Products in Some ESA Countries

Country	Potential for PPPs
Ethiopia	Opportunities for PPPs in Ethiopia are limited, but private companies are legally required to share climate and weather data with the NMHS.
Malawi	The PPP Bill and PPPs Commission facilitate PPPs in Malawi.
Tanzania	There is a dedicated PPP Unit in the country (Tanzania Investment Centre).
Uganda	There is scope for PPP between the NMHS and the private sector. Legally, the NMHS is the sole provider of weather information in the country. Demand for information has been expressed by the private sector - particularly aviation, construction, and mining. Currently, there is a cost recovery agreement between the NMHS and Uganda's Civil Aviation Authority.
Zambia	The Meteorological Bill promotes PPPs in the development of meteorological services, particularly for the following sectors: (a) aviation, (b) agriculture, (c) water resources management, (d) education and research, (e) health, and (f) building and civil engineering.

Source: Adapted from Mills 2016.

The establishment of PPPs should not be limited to NMHSs but also to address broad food security EWSs needs. However, for the PPP to be effective at both regional and national levels, these should be supported by legal frameworks, protocols, and MOUs for partnerships to yield maximum benefits. These arrangements should provide guidance and clarity on the benefits of private sector interventions, including their contributions in terms of human and technical resources as well as the products and services to be delivered. In most instances, support will still be required from international development and cooperation partners for the design and strengthening of the enabling environment for effective PPPs with e.g. mobile network companies, water, and electricity utility companies as well as with private enterprises engaged in weather- and climate sensitive sectors, such as agribusiness, fisheries, and tourism.

CHAPTER FIVE: BEST PRACTICES AND RECOMMENDATIONS FOR INSTITUTIONAL STRENGTHENING

5.1 Introduction

This chapter presents three cases of good practice that have been drawn from within and outside ESA. The exemplars include good practices on PPPs, food security information systems, and feedback forums to help improve delivery of the EWS.

First, this study found that there was limited engagement between the public and private sectors in production, monitoring, dissemination, and utilization of EW information. This is despite the increasing demand for greater involvement of the private sector in the provision of climate services to inform adaptation decisions. The Environmental Analysis and Remote Sensing (EARS) and other emerging entrepreneurs in Africa are explored to highlight the potential benefits of involving the private sector in climate services provision.

Second, food security and EW information systems are generally weak at both national and regional levels. Consequently, the users do not receive timely EW information to help them make decisions that will trigger appropriate action. The ASEAN region appears to have successfully set up a regional food security information system that has responded to the needs of the member states.

Finally, as the purpose of the EW information is about triggering action on the ground, setting up a framework for users to integrate science-based and traditional climate forecasts adds value to the people's lives. This also helps the producers of EW information to improve ways of packaging EW information to meet user needs.

5.2 Innovations for Improving Food Security EW: Role of the Private Sector

As this study attests, there is potential for the private sector to play a critical role in complementing the public sector efforts to satisfy the demand for climate services in the ESA countries. EARS is one of the private initiatives that provides a sustainable business model that can complement the NMHSs capacity (Box 5.1).

Box 5.1: Good Practice from EARS

Since 2012, EARS has been involved in piloting a project in Senegal using different climate data collection techniques, including satellites, to improve data quality for Weather Index-Based Insurance (WIBI). Depending on the design parameters, climate, and drought sensitivity of the crop, the index detects when the drought level is such that yield losses are imminent. In that case, a payout for that location is triggered by the index.

After the first year, the project demonstrated that there is considerable potential for improvement to calibrate the weather indices by (a) incorporating additional ground data made available by the project; (b) interacting directly with local experts, including NMHS staff; and (c) integrating different methodologies.

Background. EARS is a remote sensing and geo-informatics company that has developed its own innovative technology, known as the Energy and Water Balance Monitoring System (EWBMS). This technology is used to derive and map temperature, radiation, evapotranspiration, cloudiness, and rainfall data from Meteosat data. EARS has processed 33 years of Meteosat data on evaporation and precipitation data fields that cover the entire African continent at a 3 km spatial scale, with daily temporal resolution. This Meteosat reception and processing continues in real time at the head office. In addition, EARS receives data from the WMO Global Telecommunication System for calibration and validation purposes. Based on the aforementioned data, EARS has developed systems and services for river flow forecasting, drought monitoring, crop yield forecasting, and crop index insurance.

The model. Since 2009, EARS has been developing a micro-crop index insurance called the Food Early Solutions for Africa (FESA). This initiative aims to insure farmers against damage caused by drought, extreme precipitation, and winter or night frost. Once farmers have signed up for the insurance, EARS will use the Meteosat receiving system to (a) monitor the index during the growing season; (b) calculate payouts; and (c) report the results. The project was co-funded by the Ministry of Foreign Affairs of the Netherlands as a contribution to achieving the UN Millennium Development Goals.

Benefits. FESA has been developing and providing low-cost drought and excessive precipitation insurance in Senegal, Mali, Burkina Faso, Benin, Kenya, Tanzania, Rwanda, Uganda, Malawi, Mozambique, and Botswana. However, as with many micro insurance schemes, the model was found not to be commercially viable without public sector funding.

Upscaling and satellite data versus ground weather stations. Through the use of Meteosat-derived data, full spatial coverage and long-time series can be provided in Africa through EARS. These satellite-derived data can address the current geographical gaps that exist between meteorological ground stations in Africa. However, the investment and O&M of these satellites are expensive. To provide the long time series that are required for a proper risk assessment and insurance design, the satellite data need to be complemented by real-time data from on-the-ground weather stations.

Relationship with the NMHSs. EARS is a provider of tailored climate information systems and products that are generated from Meteosat-derived data. EARS therefore does not use data from the NMHSs. As a result, the company has only incidental relationships with NMHSs, often with the objective to obtain data that are not available through the WMO Global Telecommunication System to validate satellite weather data.

Source: Mills et al. 2016, 27–28.

In addition to international companies such as EARS, small to medium entrepreneurs are emerging, who have the capacity to develop user-specific weather products to a variety of market segments and disseminate this information, the result of which would strengthen the weather information value chain. Severe Weather Consult (SWC) in Rwanda is another example that has recently been established to provide weather information services. SWC, for example, has piloted a weather information service in Rwanda following a market survey that identified weather information needs for farmers and city dwellers. As weather data were not available promptly, SWC opted to install a few ground weather stations with which they will combine saturate data. In future, SWC will charge farmers to sustain the system, and they will continuously explore other areas where data could be valuable such as lightning information.

However, involving the private sector in weather information products and services needs some considerations of key issues.

- The legal frameworks would need to be amended to allow for the participation of non-government entities in the provision of weather and climate services. In most countries across the ESA region NMHSs are the sole authoritative providers of basic weather information products and services, and this condition continues to be considered as the most effective scenario. In Ethiopia, for example, the National Meteorological Agency is the sole authority and provider of tailored climate and weather information products. For the legal framework to be amended, it is likely to take some time before to liberalize the weather and early warning information services.

- Consistent with WMO's Resolution 40 (Cg-XII), which urges members to strengthen their commitment to the free and unrestricted exchange of meteorological information, the resolution highlights the need to strengthen the role of the NMHS, particularly in regard to the potential impact of commercialization of basic services and the impact of for-profit activities by private sector enterprises. Accordingly, the Resolution states the following, "*considering... (4) The continuing requirement for Governments to provide for the meteorological infrastructure of their countries, (5) The continuing need for, and benefits from, strengthening the capabilities of NMSs, in particular in developing countries, to improve the provision of services, ... (6) The dependence of the research and education communities on access to meteorological and related data and products, ... (7) The right of Governments to choose the manner by, and the extent to, which they make data and products available domestically or for international exchange, ...Recognizing further: (1)The existence of a trend towards the commercialization of many meteorological and hydrological activities, (2) The requirement by some Members that their NMSs initiate or increase their commercial activities, (3) The risk arising from commercialization to the established system of free and unrestricted exchange of data and products, which forms the basis for the WWW, and to global cooperation in meteorology, (4) Both positive and negative impacts on the capacities, expertise and development of NMSs, and particularly those of developing countries, from commercial operations within their territories by the commercial sector including the commercial activities of other NMSs, Reminds Members of their obligations under Article 2 of the WMO Convention to facilitate worldwide cooperation in the establishment of observing networks and to promote the exchange of meteorological and related information; and of the need to ensure stable ongoing commitment of resources to meet this obligation in the common interest of all nations*.[27]"

- The installation of new weather stations is unlikely to be always consistent with the WMO standards. One of the approaches to creating this consistency among weather stations is to ensure that all installations of weather stations is done by the NMHS. In Tanzania, the government has made it compulsory that weather stations—from both the public and private sector—be installed by the Tanzania Meteorological Agency (TMA) and TMA staff are trained to maintain these stations. However, the challenge here is that many ESA countries have limited capacity to deploy and maintain their own networks. It is therefore

[27] World Meteorological Organization, WMO.
http://www.wmo.int/pages/prog/www/ois/Operational_Information/Publications/Congress/Cg_XII/res40_en.html

unlikely that the NMHSs will have the capacity to manage a commercial operation. As indicated, there is a recognition that the governments have the responsibility for the allocation of adequate resources for the NMHS, that will allow them to properly discharge their institutional responsibilities, including becoming the authoritative source of hydromet monitoring and forecasting information to improve the country's decision-making and investment planning processes. Currently, most NMHSs in the ESA regions do not have the capacity to compete with the private sector in areas such as staff training, equipment maintenance, or payment of subscriptions for certain specialized services.

5.3 ASEAN Food Security Information System

Southeast Asia is one of the most disaster-affected regions in the world, with the region having experienced two of the world's mega disasters during the last decade: the Indian Ocean tsunami in 2004 and Cyclone Nargis that hit Myanmar in 2008. More recently, the floods in Thailand in 2011 caused over US$45 billion in damages and the latest major disaster, super typhoon Haiyan, was the deadliest disaster in 2013, with more than 6,000 fatalities. According to the International Disaster Database, the region accounted for over 31 percent of all global fatalities from disasters and 8.83 percent of those affected by disasters from 2003 to 2013. Losses related to natural disasters cost the ASEAN region, on average, more than US$4.4 billion annually over the last decade.

Founded on August 8, 1967, by Indonesia, Malaysia, the Philippines, Singapore, and Thailand, ASEAN's goal was to accelerate economic growth, social progress, and cultural development and to promote peace and stability in the region. After the Cold War, its membership expended to 10 by admitting Brunei Darussalam, Cambodia, Lao, Myanmar, and Vietnam. Located in Jakarta, Indonesia, and led by the Secretariat, ASEAN consists of four major departments: Political and Security Community, Economic Community, Sociocultural Community, and Community and Corporate Affairs. In 2012, the Secretariat had a budget of US$15.7 million and 260 staff.

To fulfill its objectives, one of the initiatives of ASEAN was to create the ASEAN Food Security Reserve (ASFR) in 1979. Following the establishment of the ASFR, several initiatives were also initiated. This includes an agency, which would manage the regional emergency rice reserve, assess in phases the level of food security in the Southeast Asian region, and prepare information about the food security development policy in member states. This initiative led to the setting up of the ASEAN Emergency Rice Reserve (AERR) for use during crisis. The term 'emergency' was used to refer to the states or situations citizens of ASEAN member states that are subjected to extreme suffering resulting from disasters of a natural or anthropogenic origin. Some disasters would overwhelm the member states' capacity to address such circumstances through national reserves and also leave them unable to cater to the supply need through normal trade channels (Briones 2011). Two decades later, establishing a food security information system, AFSIS, was initiated. Today, AFSIS has become a critical element of the ASEAN nations as it has become the basis of EWS information.

Established in 2003, AFSIS was born out of the agreement at the first meeting of the ASEAN Ministers of Agriculture and Forestry and the Ministers of Agriculture of the China, Japan, and

South Korea held in 2001. The aim of AFSIS is to provide accurate and reliable information timely, which is necessary for the food security in the ASEAN region.

To achieve the objectives, AFSIS is supported by two main components: Human Resource Development and Information Network Development. First, the Human Resource Development aimed at raising the technical capacity of member states at two levels. The first level was done through a combination of activities such as training, workshops, and national seminars. These activities were planned to provide related personnel in member states with knowledge and skills in statistics and the development of food security information system to ensure that they will be capable to implement the project's activities competently and at the same standard.

At the second level, the project introduced the activity for mutual technical cooperation to replace the national seminars of the first level. The objective was to share the knowledge and views among the ASEAN member states through the organization of training courses and technical visits. Under this activity, the more advanced member states were requested to help improve the capacity of the others to accomplish the implementation of the project's activities.

Third, the Information Network Development component focused on the development of regional food security information network. This included the development of the database to enable stakeholders in member states to disseminate and acquire food security-related data required for policy planning and implementation. This component also planned to provide member states and the project management units with the sets of computer hardware with printers and necessary application software as well as annual operating costs to develop information networks at national and regional levels.

Having built the technical capacity and the appropriate physical infrastructure, the project emphasized on the enrichment of database and data analysis. The development of Early Warning Information and Commodity Outlook was included to monitor and analyze food security situation in the region. In addition, the project planned to provide a number of network equipment to some member states as considered necessary for project implementation.

The expected outputs of the project were as follows:

- Member states will be capable of providing accurate, reliable, and timely information required for the construction of regional food security information at the same standard.

- The project will be able to provide complete information needed for planning and implementation of food security policy in the region.

- The development of EW information and commodity outlook will facilitate the management of food security policies and programs. These activities will help assess food security situations in the region and identify the areas where food insecurity is likely to occur as well as the degree of seriousness.

- The responsible agencies to be better aware of the problem in food security, so that affected people will receive better responses and support to release their difficulties.

5.3.1 AFSIS Institutional Arrangements

The key institution, which oversees the implementation of AFSIS, is focal point agencies group from every member state. This group is responsible for managing and assisting in carrying out the activities of the project. The functions are organized through the focal point meeting (FPM).
The FPM is the decision-making mechanism of the project and is held at least once a year to discuss, review, and decide on the following:

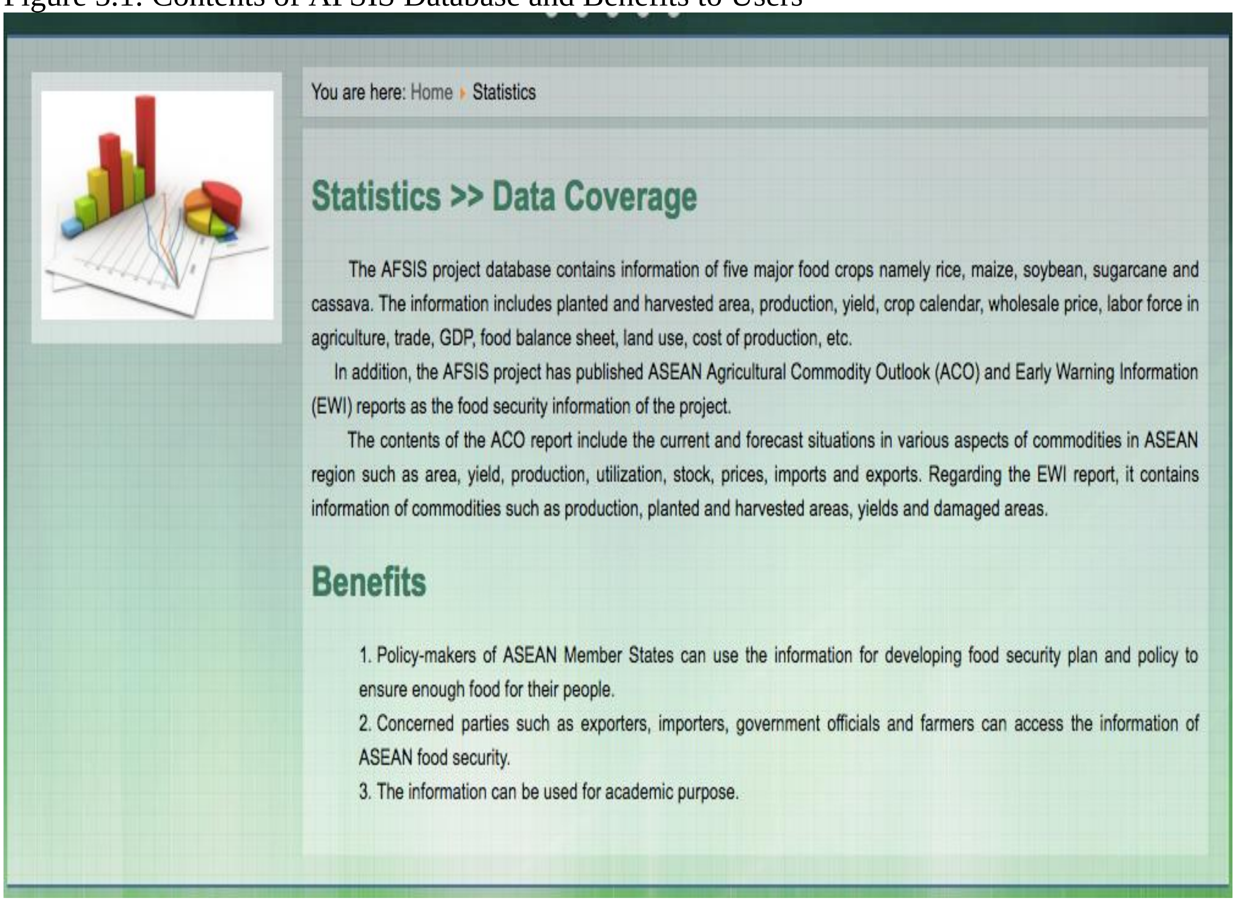
- Work plans of the project
- Implementation of project activities at the regional and national levels
- Other important matters relevant to the implementation of the project

The ASEAN Food Security Information and Training Centre, in the Ministry of Agriculture and Cooperatives in Thailand, is the secretariat of the FPM and also doubles as a center for regional training and as a hub of information on regional food security.

5.3.2 Food Security Information Database

Figure 5.1 summarizes the food security database and the benefits to member states and other users.

Figure 5.1: Contents of AFSIS Database and Benefits to Users



5.3.3 Lessons for ESA Countries from the AFSIS Project

- AFSIS is a legally binding policy framework for cooperation, coordination, technical assistance, and resource mobilization in food security information systems in the ASEAN member states. If the ESA countries should adopt a similar system, then they need to consider developing a legally binding agreement.
- The AFSIS FPM is made up of the respective food security focal points to oversee the implementation of the program. The ESA countries could adopt the same framework perhaps through the already existing working groups, for example, FSNWG in IGAD and Regional Early Warning Unit (REWU) in the SADC. However, these systems will need to be institutionalized.

  It is also learned that the resources for AFSIS are mobilized by member states, and if the ESA countries would like to sustain the benefits of such a project, then they should mobilize resources internally.

5.4 Participatory Scenario Planning for Coproducing User-based Climate Services

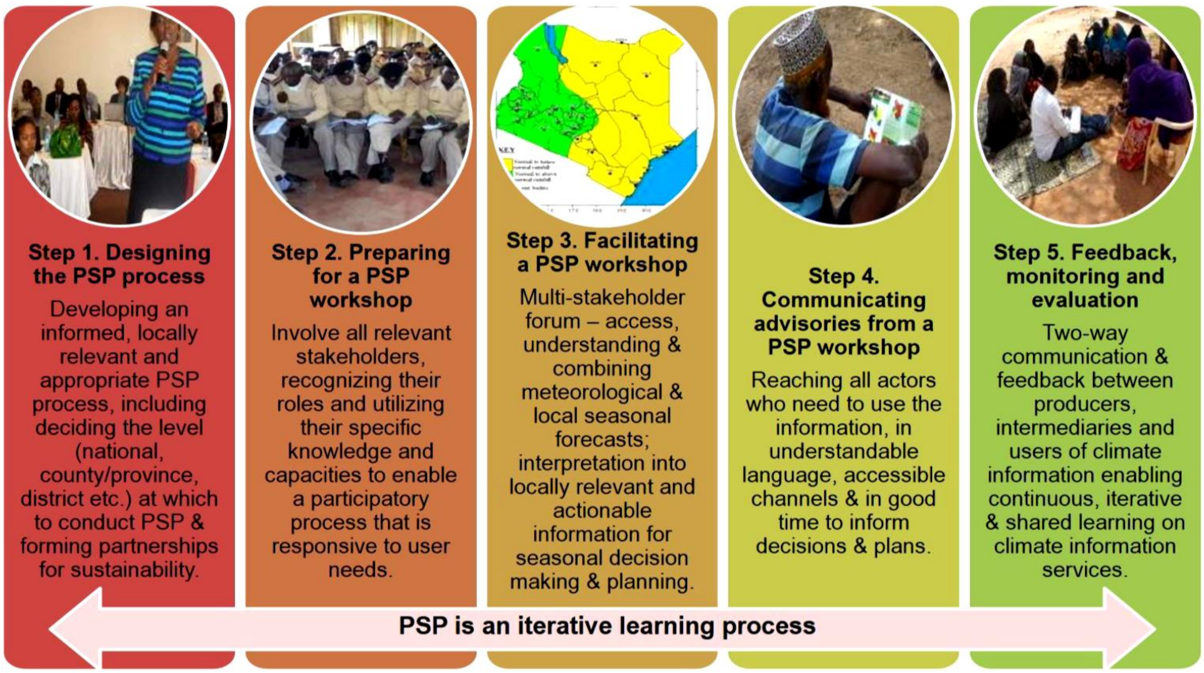
Application of climate and weather information at the local community is one of the key bottlenecks that has been highlighted by participants of this study. At the local level, for example, in Mbeta Island in Zambia, it was clear that access to weather information is limited and, if available, is often not specific enough, not easily understood, or not framed as actionable decision points. In Zimbabwe, climate information from meteorological services is often viewed as of high quality and based on science and technology, but this information is of limited value since it has limited interface, if any, with local knowledge from users, particularly farmers.

Participatory scenario planning (PSP) is one of the tools that provides an opportunity to integrate science-based climate information and context-specific local knowledge (Box 5.2). Successful adaptation and resilience to climate variability and change requires building people's capacity to continuously make adaptive decisions that review, anticipate, and have the flexibility to respond to climate risks, uncertainties, and opportunities. To make good decisions, the government at different levels, organizations, and communities need context-specific information on the climate and its uncertainties, potential climate impacts, and response options.

Box 5.2: Application of Climate Information through PSP

PSP is a method used by CARE International under its Adaptation Learning Program (ALP), implemented in Africa, for the collective sharing and interpretation of climate forecasts. The ALP supports communities and local governments to use seasonal climate forecasts and information on climatic uncertainty for decision making, as part of the community-based adaptation (CBA) approach.

Figure 5.1: Five Major Steps of the PSP Process



Source: http://careclimatechange.org/wp-content/uploads/2017/03/ALP-PSP-Brief-2017.pdf.

The PSP method creates space for meteorologists, community members, local government departments, and NGOs to share scientific and traditional local knowledge. It allows these stakeholders to find ways to combine and interpret these two sources of information into locally relevant and useful forms. Participants of the PSP method consider the probabilities of changes in the climate; assess their likely hazards, risks, opportunities, and impacts; and develop scenarios based on such an assessment. They discuss the potential implications of these scenarios on livelihoods, which lead to agreement on plans that respond adequately to the identified levels of risk and uncertainty.

For example, in Kenya, the PSP method helped local communities make local agricultural decisions by prompting consideration of the different types and varieties of crops that would respond to the different levels of risk. Decisions were made about what crops to plant in the coming season and, crucially, how much of each crop type and variety to plant so as to spread the risk of total crop loss due to whatever climate that actually occurred. Plans were also made about risk reduction strategies that needed to be put in place by communities and how local government and NGOs could support these strategies through their ongoing and planned activities.

Source: **https://unfccc.int/files/adaptation/nairobi_work_program/application/pdf/care_psp_indigenous_knowledge.pdf** (accessed June 13, 2017).

5.5 Quality Assurance Measures and Service Improvements through Producer-User Interface Forums

One of the criticisms leveled against producers of the food security EW information is not only limited understanding of user needs but also feedback from users. It is then critical for the EW producers, including NMHSs, agriculture departments, UN agencies, NGOs, and private sectors providers to regularly assess service quality by evaluating current products and services, as well as using surveys and focus group interviews. Such assessments are likely to increase understanding of gaps in service provision in terms of who is accessing information, how that information is being used, and the experience of users in matching that information to their specific needs as well as explore potential demand for new services.

Srinivasan et. Al. (2011) outline the benefits of creating a user platform to provide a two-way dialogue between producers and users EWS as one of the ways of reaching climate information users. Climate forums were initiated by Asian Disaster Preparedness Centre (ADPC) in several countries in Asia, including Mongolia, Myanmar, Sri Lanka, and Vietnam. The climate forums helped build institutional mechanisms for communicating forecasts to users and for allowing feedback from users to providers. It is a regular two-way dialogue and multi-stakeholder process of understanding and applying climate information. The climate forum is usually initiated and facilitated by the national hydrometeorological agency and includes participation by different stakeholders from the public and private sectors. The climate forum draws upon Indonesia and the Philippines as they have extensive experiences in institutionalizing climate forums at national and local levels.

In March 2003, the Philippine Atmospheric Geophysical and Astronomical Services Administration (PAGASA) initiated the national-level climate forum in the aftermath of two severe El Niño events (1997–1998 and 2002–2003) that demonstrated the need to establish a platform for discussing climate forecasts. The holding of a local-level climate forum was also initiated at the provincial level.

In general, the objectives of the climate forum are following:

- To ensure that forecast products, including their uncertainties and limitations, are understood by and communicated to users;
- To encourage risk mitigation in various climate-sensitive sectors; and
- To provide a platform for interagency coordination of policies and programs for dealing with potential impacts of climate-related hazards on a season-to-season basis.

As the countries have different contexts, the mechanics and specific objectives of climate forums are in recognition of the diverse institutional characteristics and mandates. To ensure regularity, the climate forum is anchored around a recurring phenomenon, such as the onset of the monsoon. Meetings are convened at least twice a year, just before the onset of the monsoon and after the monsoon. The risks and opportunities characterizing each season vary to a great extent, and hence it is important that the forecast providers and users meet more frequently to make sure that the nature and timing of risks are well understood.

For climate forums to be successful, several conditions should be present. Critically important is that the users must be willing to participate and constantly engage the hydrometeorological service. Second, the national hydrometeorological agency should have a good understanding of the user context. It should have an understanding of the following:

- Who are the users and what are their key activities, for example, water resources management, agriculture, disaster management, or public health?
- What kind of climate information do they need to carry out their functions more effectively and when is this information needed?
- Do they have the capacity to receive, interpret, and translate climate forecasts into sectoral impacts? If not, what capacity-building activities are needed?

Having a communication plan between forecast providers and users is essential. There should be regularity in releasing forecast information. Users should also give regular feedback to the national hydrometeorological agencies in the form of post-season reports or other channels. Finally, users, specifically user agencies, must have a mechanism for receiving and utilizing climate information within their respective organizations.

The experience in Myanmar indicates that sometimes there is no need to come up with entirely new mechanisms for allowing feedback from users to NMHSs. Some user agencies have a long-standing practice of preparing post-monsoon season reports. Most of the questions relate to the usefulness of information decisions made by users, actions that were taken, and lessons learned (Srinivasan, Rafisura, and Subbiah 2011).

- What were the expected and actual climates as forecasted by the hydrometeorological agency?
- What were the options considered or recommended by the department to end users?
- What options were adopted as the season progressed?
- What were the impacts?
- What were the lessons learned?

5.6 Summary of Findings and Recommendations

While progress has been made, there are challenges, which recur across the RECs and member states. Most of these challenges fall into the following three categories:

Institutional Challenges

- Lack of EWS working groups in both RECs to coordinate EWS activities. In the IGAD region, the institutionalization of the FSNWG has been slow as the FSNWG is yet to be endorsed as an institution of IGAD.

- Policies that outline roles and responsibilities for EWS actors at both regional and national levels are generally weak. Although many ESA countries have sector policies, the sectors still operate in silos due to lack of overarching EWS policies. In addition, although several tools such as the IPC have manuals that guide users, these have not been endorsed by regions and member states to provide guidance on systematic data collection, data sharing, monitoring, and agreed action triggers.

- Although the GHACOF report is much on the actions that users need to consider as compared with the SARCOF reports, which are still expressed in probabilities, some users such as pastoralists are still excluded as the reports are in English. While the start and end dates for the season are useful, there is still a gap on the intensity and frequency and for the information to reach some of the users.

- Lack of regular updates of the RFBSs and NFBSs and weak monitoring of grain markets, cross-border trade, commodity price monitoring. Although FEWSNET and the WFP actively monitor these activities, integration of some of these into regional and national systems is still limited.

Technical Challenges

- While the SARCOF and GHACOF processes are well established in providing regional climate forecast, there are still challenges to downscale these forecasts to local levels such as districts or villages. Another limitation of GHACOF and SARCOF is that they tend to focus on rain and pay little attention to other parameters.

- Limited coverage of the weather observation networks and challenges in crop production forecasts makes agrometeorology data less reliable. The capacity of NMHSs in Africa is not adequate and considerably degraded in some countries during the last 20–25 years.

- In some countries, there is a lack of technically qualified professionals such as meteorologists; agrometeorologists and hydrometeorologist to ensure quality hydrometeorological products.

- Although the VAC system has become one of the most useful and reliable EWS tool in the SADC, there are multiple methodologies that need harmonization. The IPC procedures allow for the incorporation of the most reliable relevant information from multiple sources. There is a system for weighing the credibility of the source. As the sources of data become more reliable the IPC estimates become more accurate, contributing towards improving the level of understanding of evolving food security situations. Although the IPC protocols continue to gain currency across the ESA regions, there are challenges to its general adoption by national governments, due in part to differences in the manner some countries account for food security outcome indicators, some using actual metrics others rely on proxies of those indicators.

- Weak food security information systems and absence of a framework for sharing EWS data at both regional and national levels, makes EWS information slow to reach users. However, it is key to understand that while regional and national-level EWS are complementary these play entirely different roles at their respective geographic scales. Regional level EWS are not required to provide guidance on site-specific interventions, while the national EWS are expected to transform risk knowledge into effective on-the-ground interventions for reducing risk and protect lives and assets.

Sustainability and Financial Challenges

- There are no clear funding mechanisms for EWSs. While conceptually part of the country's emergency preparedness of the country, in many nations EWS programs are perceived as part of the emergency response activities. Consequently, funding for EWS tends to *be ad hoc*, oftentimes competing for funds during the emergency response. In addition, because EWSs rely on international assistance, which tends to be project based, they often face financial sustainability challenges once the external funding ceases. However, in general, national government authorities and other relevant stakeholders across the ESA regions have a pretty good understanding of the need for effective, timely EWS, as they have joined the Hyogo Framework for Action (2015-2015) and the Sendai and most countries have ratified the Sendai Framework for Disaster Risk Reduction; and have established partnerships with specialized agencies of the United Nations, such UNDP, UNEP, UNICEF, WFP, FAO, and the World Bank, the AfDB, EU, etc. The chronic financial constraints that affect many countries in Africa are the primary reasons why adequate ex-ante resources are not allocated for EWS. Most countries are becoming increasingly aware of their contingent liabilities and are exploring mechanisms to reduce them, including exploring the establishment of disaster risk financing and transfer strategies. The World Bank's Africa Program has an ongoing policy dialogue with most countries in the region, aimed to help national governments to find was to improve regional collaboration and coordination to address food insecurity, through among other mechanisms, improved EWS that are adequately funded by the government.

- There is limited private participation in the provision of climate services. However, it is hypothesized that PPPs could contribute to reducing countries' reliance on external donors. There is uncertainty, however, over the nature of the relationship between the NMHSs and the private sector. There is also a perception that the private sector may be a threat to data ownership and the ability of governments to fulfill their national and international commitments regarding the provision of basic hydromet services as a public good, including data for EWSs.

5.7 Recommendations

Key areas that require investment.

Strengthening Institutional Capacity Framework

- **Strengthen the EWS governance at both the national and REC levels by improving legal and regulatory frameworks, and coordination and ensuring clarity of roles and responsibilities at each EWS phase.** This will also include developing common methodologies and procedures for data collection, management, and data sharing across geographical borders.

- **Develop and strengthen the Food Security Information System at both the national and regional levels to meet the RECs, African Union (AU), and member states agendas, including the Comprehensive Africa Agriculture Development Program**

(CAADP). The information should serve regular development, EWSs, and emergency preparedness and response. The RECs in the ESA region should consider establishing a Food Security Information System like that of the ASEAN Food Security Information System (AFSIS) to strengthen the food security EWS. This will be supported by a data sharing framework and a one-stop food security information hub such as an Emergency Operation Centre that is accessible to users from governments, the public, and the international community. The regional Food Security Information System should also be replicated in each of the member states.

- **An effective all-hazards regional technical committee, with a remit on food security EWS, needs to be reviewed, strengthened or created where one does not exist.** This will improve the coordination, communication, packaging, and delivery of information in the region especially in terms of better joint preparedness and response plans. The mandate should include multi-hazards and specific hazards such as pest infestations like the FAW. The regional EWS committee should be replicated in the member states.

- **Develop innovative but carefully designed Public Private Partnerships (PPPs) that have the potential of improving the sustainability of climate and EWS.** PPPs have the potential of breaking the downward trend of relying on external funding, addressing weak infrastructure, deficient services, and low visibility that have a negative impact on efficient and effective EWS services. The increasing access to the Internet has spread rapidly across Africa, which also provides an opportunity to engage the private sector to collect near-real-time data from automatic weather stations (AWSs) and to disseminate this information, alerts, and warnings to improve food and livelihood security. This will require the ESA countries to be proactive to engage with private international and local weather and climate information services providers.

- **Hydro-meteorological monitoring and forecasting, and the maintenance and operation of the observational networks will continue to be an activity that is best carried out by specialized government agencies, as a government monopoly, and the services generated by such a monopoly provided as a public good.** The privatization of key government functions that have been traditionally carried out by the NMHSs is a contentious issue. Mostly, because establishing the required observational networks is a capital-intensive endeavor that is not, in general, profitable from a business perspective. Considering private participation is a relatively new territory for the ESA countries, its integration into the existing structures will require a phased approach that can allow for experimentation, testing, flexibility, evaluation, and sharing of lessons learned as the innovations progress.

- **PPPs shall be supported by legal frameworks and agreements that outline the roles and responsibilities of the participating partners, data policy, and intellectual property rights to ensure the public goods service of EWS is not compromised.** It is also key to understand that private enterprises will find unprofitable to maintain the required technical infrastructure, for periods of time that can span for generations and for future uses that are not even known yet, or for which the expected return on investment cannot be estimated. Private enterprises would be discouraged to invest in infrastructure to cover geographic areas where e.g. they don't have markets or if potential markets exist, such markets are unprofitable. However, private entities can benefit from government services provided at no cost to all. For instance, Hydromet information can be used to develop and promote whole new industries, including e.g. parametric agricultural/flood risk insurance; which in turn would contribute to reducing the government's contingent liabilities resulting from adverse hydro-meteorological events. In this regard, certain specialized weather services can be taken up by the private sector, building on the basic services, provided by the government NMHSs.

- As the technical capacity of NMHSs improve, these agencies could also provide specialized fee-based services. For instance, in many countries airlines pay for additional weather-services at airports.

- NHMS will continue to derive their core funding for operations & maintenance, and research from the government budget.

Improve Technical Capacities and Knowledge Exchange

- **Invest in technical capacity development to enable the collection of high-quality agrometeorological crop production forecasts and vulnerability data.** EWSs require (a) improved capacity to downscale regional climate forecasts to high resolution for the forecasts to be meaningful at the local level; (b) strong weather observation networks with a wider coverage; and (c) improved data collection for crop assessments, livestock assessments, and vulnerability assessments. The SADC's Vulnerability Assessment and Analysis (VAA) as well as the IPC methodologies should be harmonized or at least agree on minimum indicators to ensure quality assurance and comparison among countries.

- **Improving capacity building is key for ensuring that NMHSs are capable of discharging their mandates.** However, the chronic underfunding of many, if not most, NHMSs across the developing world, --already struggling to stay financially afloat, and consequentially not very effective or relevant for government decision-making--, makes it hard to persuade financially-constrained government officials to invest in future, oftentimes unknown or undetermined benefits. For this reason, among others, it is critical to come up with ways to demonstrate the current economic value of effective and efficient NMHSs.

- **Review and strengthen monitoring of the Regional Food Balance Sheets (RFBSs) and National Food Balance Sheets (NFBSs), grain markets, cross-border trade, and commodity pricing monitoring and agree on action triggers when thresholds are reached.** There is a need to develop market monitors for cross-border trade to help monitor prices and volumes to determine the food security levels in the countries. The monitoring and warning service should be supported by regional standard operating procedures (SOPs).

- **Improve knowledge of emerging threats such as pest infestations (FAW) by strengthening links with local universities and research institutes.** For example, collaboration with botany and biological sciences, and linking these with the meteorological departments. Improving agricultural productivity goes hand in hand with improved weather and climate forecasting capabilities, which in turn contributes to enhancing the provision of Agricultural Extension Services (AES). However, AES do not necessarily materialize without the concerted effort of key stakeholders from government agencies, non-government organizations, and academic/research institutions. AESs have a substantial impact in protecting the livelihoods of households engaged in agriculture, and consequently, in reducing or mitigating the risk of food insecurity among vulnerable populations.

- **Promote south-south knowledge exchanges.** For example, exchange of information between AFSIS and RECs in the process of developing their Food Security Information Systems. Inter-REC knowledge exchanges such as Agriculture, Hydrology and Meteorology (AGRHYMET) Regional Centre of the countries of the Permanent Inter-State Committee for Drought in the Sahel (CILSS) could also be considered.

- **Develop and strengthen community-based VACs.** Including knowledge and best practices sharing among ESA countries.

Leverage Available Financial Resources

- **Strengthen public commitment and mainstream EWS considerations into agricultural/food security policies, budgetary allocations, and planning frameworks.** This will require evidence-based advocacy to regional leaders and cooperation development partners on the economic benefits of EWSs.

- In Uganda, for instance, the Government has demonstrated its awareness of the existing nexus between weather, climate, and water and food insecurity levels. The Government of Uganda's has adopted medium and long-term strategies for reducing the risk of food insecurity, including the incorporation of key concepts of Climate Smart Agriculture concepts, which depends on improved hydromet monitoring and forecasting capabilities, that also contribute to effective end-to-end EWSs. To achieve similar goals across the ESA regions, national governments need to create the enabling environment for policy dialogue that promotes the paradigm shift from responding to food insecurity crises towards managing food insecurity risks, an endeavor that requires a multidisciplinary engagement, across multiple sectors and levels of government administration.

- **There is a growing body of evidence that demonstrates that the societal value of certain government services, including weather and climate monitoring and forecasting services far exceeds their direct costs** (on par with other government-funded services such as public education and health programs). The BCR of investments in Hydromet, EWS and similar services, generally paid by the national government and provided as a public good, demonstrates the societal gains of providing such services at-no-cost to the public, including the private sector. However, there is potential for implementing effective and efficient cost-recovery measures in the ESA countries, particularly considering that the NMHSs are essentially the only agencies providing weather and climate services.

- **Scale up technical support and investment under schemes such as the World Bank modernization of hydrometeorological infrastructure and institutional strengthening and capacity building of targeted NMHSs with an added emphasis on strengthening subnational institutional capacity.** There is also a need to consider leveraging on climate and development finance and build in a ‘weaning phase’ into EWS projects financed by development partners to ensure sustainability of benefits.

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ANNEX: SOME GOOD PRACTICE OF EARLY WARNING SYSTEMS

Name	Host	Description	Link
ICPAC	IGAD	ICPAC provides (a) timely climate EW information and support to specific sector applications for the mitigation of the impacts of climate variability and change for poverty alleviation, management of environment, and sustainable development; (b) technical capacity building of producers and users of climatic information to enhance the use of climate monitoring and forecasting products in climate risk management and environment management; (c) proactive, timely, broad-based system of information/product dissemination and feedback, at both the subregional and national scales through national partners; and (d) support to maintain quality-controlled databases and information systems required for risk/vulnerability assessment, mapping, and general support to the national/regional climate risk reduction strategies.	http://www.icpac.net/
CSC	SADC	The CSC provides (a) operational and regional services for monitoring and predicting extremes in climate condition and (b) develops and disseminates meteorological, environmental, and hydrometeorological products, and hosts the SARCOFs, which are designed to develop region-wide consensus on climate outlooks in the near future. The Real Time Extreme Weather and Climate Monitoring System is the key tool used to gather and visualize all meteorological data for analysis and EW.	http://www.sadc.int/sadc-secretariat/services-centres/climate-services-centre/
Regional Integrated Multi-Hazard Early Warning System (RIMES) for Africa and Asia	RIMES member states	RIMES provides regional EW services and builds capacity of its member states in the end-to-end EW of tsunami and hydrometeorological hazards.	http://www.rimes.int/
Locust Watch	FAO	Food Security Warning System: Provides timely information on the movement of locust swarms and the potential impacts these swarms may have on food security	http://www.fao.org/ag/locusts/en/info/info/index.html
AGRHYMET	CILSS	AGRHYMET is a specialized agency of the CILSS of 13 countries. AGRHYMET has established itself as a regional center of excellence in areas/services including (a) agrometeorological and hydrological monitoring at the regional level, (b) agricultural statistics and crop monitoring, (c) regional data banks, (d) management and dissemination of information on the monitoring of natural resources in the Sahel, and (e) strengthening of interstate cooperation through the exchange of technology and methodology.	http://www.agrhymet.ne/
Flood Forecasting System	Mekong River Commission	Core River Basin Management Functions (CRBMFs) are performed jointly at the regional and national levels and include (a) data acquisition, exchange, and monitoring; (b) analysis, modelling, and assessment; (c) planning support; and (d): forecasting, warning, and emergency.	http://www.mrcmekong.org

Name	Host	Description	Link
AFSIS	ASEAN	AFSIS is designed to facilitate access to commodity outlooks, EW, and agricultural statistical data at the subnational level from the ASEAN nations plus China, Japan, and Korea, Rep.	http://www.aptfsis.org/index.php
Regional Specialized Meteorological Centre (RSMC) La Réunion	Météo-France	Multi-Hazard Early Warning System: Provides real-time weather advisories and is responsible for tracking tropical cyclones in the southwest Indian Ocean	http://www.meteofrance.re/accueil