Submission from the International Center for Tropical Agriculture (CIAT) on behalf of the CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS), to UNFCCC SBSTA 42 on issues related to agriculture in response to SBSTA decision FCC/SBSTA/2014/L.14.

These are views on the development of early warning systems and contingency plans in relation to extreme weather events and its effects such as desertification, drought, floods, landslides, storm surge, soil erosion, and saline water intrusion FCC/SBSTA/2014/L.14 paragraph 3 (a).

Expanding the Contribution of Early Warning to Climate-Resilient Agricultural Development in Africa

Summary

Extreme climate events can undermine agricultural and rural development progress. Even in years when extreme events do not occur, the uncertainty that results from climate-related risk is an impediment to sustainable intensification of agriculture and adoption of climate-smart agricultural production practices. Systems that provide early warning of climate extremes can reduce the adverse impacts of such events – if they are embedded in effective communication and linked to decision-making processes. However, there is general consensus that early warning systems are not meeting their current potential to provide decision-makers with timely information in a format that enables action. Recent failures to respond effectively to slow-onset extreme climate events – particularly drought – have generally been attributed to failures in decision-making rather than failures in early warning. Therefore any investment in developing or improving early warning systems should be coupled with investment in improving communication and decision-making processes to maximize the benefit of early warning. In order to increase response, early warning systems must also tailor information for a broader set of actors ranging from global to community level. Many institutions create early warning systems for their own operational purposes or share warnings broadly without regular feedback from stakeholders. Making appropriate early warning information available to decision-makers at a more local level can allow earlier, better targeted mitigation action that may reduce long-term impacts of climate shocks on livelihoods, and reduce the need for emergency assistance later. Such an approach would require increased capacity at local levels and regular feedback to assure that the information provided is keeping pace with local dynamics.

Recommendations

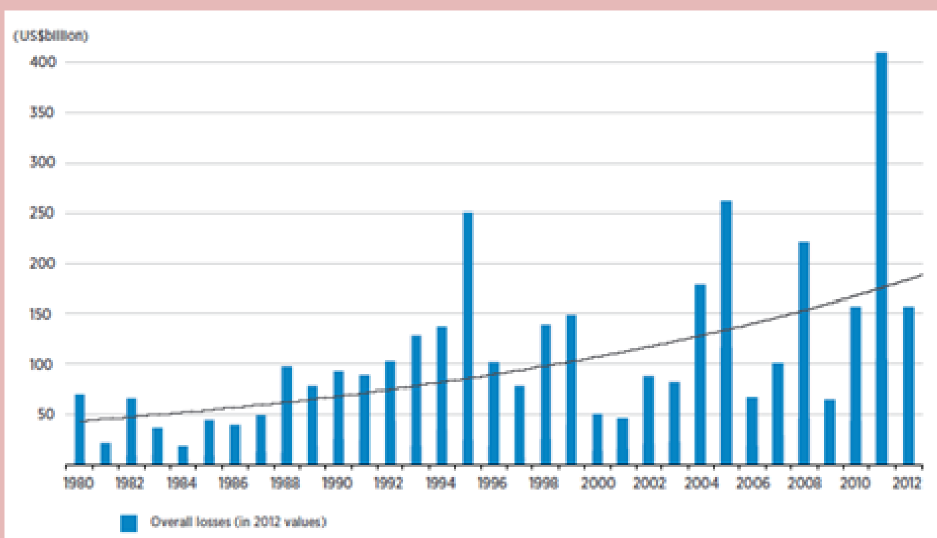
In an era of more frequent and more extreme weather events and climate shocks, enhanced early warning systems provide a key opportunity to curb erosion of development progress in rural sectors. Key recommendations for strengthening existing systems and developing news ones include:

1. **Establish objective rules for early response to early warning information, based on parametric triggers, contingency plans and contingency finance mechanisms.**
2. **Broaden the range of users of early warning information and integrate into development activities.**
3. **Early warning systems should incorporate systematic feedback from users, and change with the needs of stakeholders and new technology.**
4. **Invest in the quality, accessibility and integration of data.**
5. **Take greater advantage of seasonal prediction to increase the lead-time.**
6. **Factor uncertainty into risk analysis, communication, and decision processes.**

Early Warning, Food Security and Risk Management in Africa

Food crises can be an impediment to agricultural and economic development, especially in areas such as the Sahel or Horn of Africa. These events are slow to develop, sometimes over a period of months, but they can also be traced to early warnings. Droughts have led to the highest death toll of all natural disasters – killing between 1 and 2 million people worldwide since 1970. The majority of these deaths were in the Sahel and Horn of Africa regions. Certain socioeconomic circumstances found in many rural and urban African environments can lead to an increased vulnerability to drought, such as high poverty rates, poor access to health care and social services, high dependency on small-scale rain-fed agriculture, etc. At the same time, many African countries are in the process of dramatic growth and have made progress towards greater agricultural and economic resilience to climate impacts. Effective early warning systems will play a key role in supporting this transition and will also cut the cost of reactionary assistance at the global and national level. Reactionary spending on post-disaster relief can overwhelm national budgets and compete with funds for long-term resilience building efforts. Unfortunately, trends show that costs related to post-disaster spending are on the rise. With the increasing threat of climate change, inefficient response systems will struggle to adequately meet upcoming needs. Early warning that is linked to early action on multiple levels should be a central feature of Africa's adaptation agenda at regional, national, and sub-national levels.

Figure 1: Increase in the cost of disasters (Source: World Bank 2013)



The Sahel and Horn of Africa are experiencing increased risk to drought and famine as a result of long-term rainfall trends, rising temperatures, and ongoing political instability. However, such risks can be managed through early warning and early response. These systems monitor and forecast risk factors such as food prices, health indicators, rainfall measurements, and crop yields. Cost-benefit analyses show that investment in early warning systems saves money in the long run, as well as preventing negative impacts to livelihoods. However, there can be a disconnect between early warnings and early actions, the failure of which can drive a region into famine, after which the only response is humanitarian aid.

Recommendations

1. Establish objective rules for early response to early warning information, based on parametric triggers, contingency plans, and contingency finance mechanisms.

If a slow-onset climate stress such as drought threatens food security, Early Warning Systems (EWS) that combine remote sensing, agrometeorological monitoring, and seasonal climate prediction can generally give a good indication of the increased risk long before harvest. And yet any response to an evolving food security crisis is often delayed by many months after the evidence is apparent. The overwhelming consensus in the food security community is that the decision processes surrounding food security management are a greater constraint than the current generation of EWS. There is a strong body of evidence that delayed intervention, when a climate-related shock exceeds the coping capacity of affected communities, greatly increases both the short-term cost of providing emergency assistance, and the long-term impacts on the livelihoods of those communities.

Humanitarian response to climate-related food crises has typically involved a sequential process of monitoring, emergency assessment, appeal, resource mobilization, and emergency assistance (Haile, 2005). Even when each step is managed efficiently, this process typically involves delays of several months from the time the impacts on affected communities are established. Furthermore, institutional incentives often favor delaying action until the impacts of a shock are certain.

Several innovative initiatives are developing early response rules based on objective threshold values of early warning information. These initiatives share three common features (See Box 1 &2). First, contingency planning, or identifying sets of early actions that can reasonably be taken in response to information about growing risk from a slow-onset climate

Box 1: ***Africa Risk Capacity Program***

A new response program developed by the African Union called the African Risk Capacity (ARC) takes an innovative approach to financing response. By transferring risk from pan-African governments and vulnerable smallholder farmers to the ARC insurance risk pool, funding and resources can be mobilized to quickly respond to impending disasters. Capital comes from participating countries' insurance premiums, which are based on the level of risk and financial coverage for the severity of the climate event. (Presently, ARC only covers droughts but will expand to floods and other hazards later on.)

ARC uses "Africa RiskView," satellite weather surveillance technology to ensure that the data is accurate and up-to-date, and which will therefore allow analysts and decision-makers to quickly respond to climate warnings. When rainfall amounts are calculated to be below a determined threshold, ARC member countries receive a payout within 2-4 weeks of the end of the rainy seasons, allowing sufficient lead-time for early intervention programs to get underway before the economies and livelihoods take a significant hit. The University of Oxford, IFPRI, and Boston Consulting Group each performed a cost-benefit analysis and found ARC to be a far better investment then the status quo.

extreme, with acceptable cost and risk if the crisis does not materialize. Second, establishing objective threshold values of early warning variable that will trigger implementation of those contingency plans and which will adjust to changes throughout the calendar year. Third, contingency financing made available by the same early warning trigger. This can be in the form of insurance, a government-run risk pool, or at the continental scale, such as the Africa Risk Capacity program.

BOX 2: World Food Programme's FoodSECuRE

WFP is piloting FoodSECuRE, a multilateral fund which channels resources from WFP programs and directly connects activity planning to seasonal climate prediction. This fund will allow WFP to respond to warnings before climate shocks occur and to strengthen community preparedness and resilience. The rigor of the program will be based on analysis, programming, and planning at the national, sub-national, and community levels, as well as ongoing analysis of the program's outcomes

Often disasters approach slowly over time, and FoodSECuRE's three-pronged approach is prepared for before, during, and after. In the time leading up to the climate event, FoodSECuRE will help build resilience based on climate forecasts and early warning data. When an emergency is declared, the communities will not be caught entirely unprepared, and emergency funding will be available as needed. Following the emergency, FoodSECuRE will be able to aid in rebuilding and recovery. This year's first pilot regions will be in the Horn of Africa, Southern Africa, the Sahel, and South Asia, and the program will be strengthened and analyzed for feasibility and design improvements, as well as opportunities for new donors and partnerships.

2. Broaden the range of users of early warning information and integrate into development activities.

The potential use of early warning systems is extremely diverse, depending on the nature of the warning (e.g. drought, flash flood) and the range of responses for all the potential users of early warning information. Actors at a range of scales make decisions that can benefit from early warning information, and that impact food security and agricultural livelihood outcomes. EWS are often developed by and for international humanitarian response organizations or national governments. Decision makers operating at more local levels are often in a position to use this information for earlier and better-targeted responses, in ways that may prevent a climate-related stress from turning into a crisis. The comments of Buchanan-Smith (1997) still hold true: "…formal EWSs in Africa are rarely run by the people whom they are supposed to serve – the potential victims of famine."

The early warning community has recently placed a lot of emphasis on connecting early warning information to operational responses. While there is need for better operational linkages with early warning information, this should not be done at the expense of providing information to a broad range of users in a format they can use. For example, during a regional level drought, tens of millions of people are responding to the event. This ranges from farmers, extension, district leaders, through to national and global level actors. Creating information silos by targeting state of the art analysis for a small set of potential users does not unlock the full potential of early warning response. Instead, early warning systems should reach a broad set of actors and be integrated into development goals at multiple administrative and community levels. At present, there are many independent and ad hoc early warning systems that target specific groups (i.e. community level or national food security experts). Effective integration is rare.

Broadening the range of users appears to be one of the most promising ways to expand the contribution of early warning to climate-resilient agricultural development in Africa. Targeting decision-makers operating at more local scales has implications for the design of EWS, local capacity building, and communication channels. Although many EWS focus on conditions late in the growing season, local governments and farming communities must make many climate-sensitive decisions before the onset or early in the growing season. Providing information at longer lead times would expand the range of decisions that EWS could inform. Enabling decision-makers operating at local to sub-national levels, to benefit from early warning information may also require investment in training, in addressing unnecessary institutional impediments to making early decisions that make the best use of the best available information. It may also require investment in effective communication channels – providing access to early warning information, but also facilitating engagement and communication with decision-makers across agencies and levels of government.

3. EWS should incorporate systematic feedback from users, and change with the needs of stakeholders and new technology.

Tailoring EWS to an expanded, and more local, set of users may include: providing information at more appropriate spatial resolution, expanding the range of variables included in early warning systems, increasing the lead-time (because more local decision-makers can often act earlier to prevent crises), and providing updated information at a range of lead times.

Providing actionable information to diverse groups is impossible without feedback mechanisms that are incorporated into early warning systems. Even for early warning systems that are set up with appropriate user-group consultation, needs change over time. An effective early warning system is flexible and adapts over time to meet the changing needs of its users. This is especially true for early warning systems that contribute to an expanded set of climate-resilient development goals. Successful adaptation to climate change requires innovative agricultural systems

BOX 3: Ethiopia Climate Resilience Planning Pilot Project

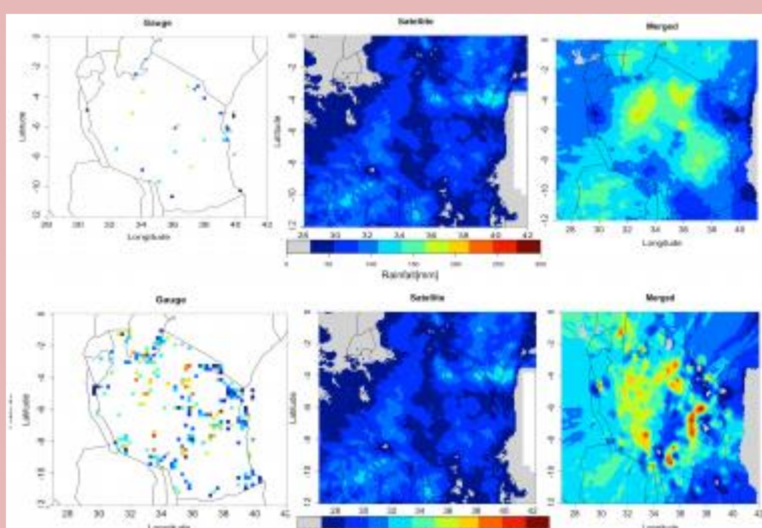
The Climate Resilient Planning Pilot Project integrates traditional early warning information with broader data to provide tailored information that is directly targeted to national and sub-national decision-processes (1) focuses on decision-maker needs through a thorough survey process, (2) develops improved information systems within current decision contexts, (3) creates a social learning platform where decision-makers and subject experts can collectively learn and build new tools, and (4) incorporates a clear monitoring and evaluation framework where outcomes of project initiatives can quickly be measured and incorporated into collective learning. The goal is to create a locally sustainable and internationally connected system of analysis that puts the most relevant and real time information in the hands of the decision-makers who need it when they need it. The project focuses on the needs of the decision-makers and the institutional mechanisms for information flow, while enhancing the capacity of institutions to respond to climate variability today, next year and 20 years from now.

and early warning systems will have to be as adaptive and innovative as the communities they serve.

Box 4: Enhancing National Climate Services {ENACTS)

EBACTS aims to provide reliable and readily accessible climate data at high resolution to decision makers in Africa. In many cases historical data are not digitized and cleaned, so they are left out of early warning analysis. ENACTS works to improve the available data and provide easy access to information users. Another critical component of ENACTS is that the process is user-led, ensuring that climate information produced builds capacity and empowers decision makers to apply the information with confidence. ENACTS is owned by national systems.

The example below from Tanzania show a comparison of station measurements (left), satellite estimates (middle) and merged products (right) for a given 10-day period. The top panel is for operational stations while the bottom one is for all available stations



4. Invest in the quality, accessibility and integration of data.

EWS are often based on multiple streams of information. Often, different government agencies, operating with different rules and different degrees of accountability to early warning, manage the different types of information. For example, statistics departments or ministries of agriculture are typically the stewards of data about agricultural production, price and food security status; while national meteorological services are responsible for weather and climate information. Confidence in early warning information is influenced by the quality of data. Furthermore, the ability to interpret current early warning information appropriately, and therefore act appropriately, depends on having access to historic time series of sufficient duration and completeness.

In terms of meteorological records, investing in data may include efforts at data recovery, digitalization, and cleaning in order to assure that countries are forecasting and monitoring weather and climate risks based on the best available historic datasets. A number of African countries are in the process of or recently completed efforts in to “rescue” rainfall and temperature data. A longer dataset allows for a more thorough analysis of trends and improves the skill of seasonal prediction. In many cases the data exist in books or microfiche and require a minimal investment to digitize and clean the data. Countries such as Ethiopia, Tanzania, Rwanda, and Madagascar have gone a step further and merged their newly digitized station data with 30 years of satellite data to create 30+ year high-resolution gridded datasets for both rainfall and temperature. These data are owned by the National Meteorological Services and are in a digitized format that can facilitate integration of data across ministries and the development of national, subnational, and community level tools that incorporate early warning information. (See Box 4 for example of ENACTS Tanzania)

The different streams of data need to be linked effectively with the broad range of information necessary to inform decision-makers in food security management and the agricultural sector. New efforts to base interventions on parametric triggers, in particular, requires integration of different data streams into integrated indicators of the impact (e.g., agricultural production, household food security status) that the EWS seeks to monitor or predict. This requires a major shift in knowledge management practices to allow for seamless integration of multiple datasets.

5. Take full advantage of seasonal prediction to increase the lead-time.

Crop and agrometeorological monitoring and early warning systems often make good use of available information for monitoring conditions late in the growing season. But early season assessments in Africa typically take a more ad-hoc approach. This includes meetings to discuss the implications of seasonal climate outlooks for food security, and subjective projections of current food security indicators into the future. The subjective nature of these long-lead assessments makes it difficult to evaluate their accuracy, calibrate them in probabilistic terms, or use them as a basis for triggering early action based on objective thresholds. Good methods are available to integrate seasonal climate forecast information into established agrometeorological monitoring tools, such as crop water satisfaction indexes or crop simulation models, in a rigorous manner.

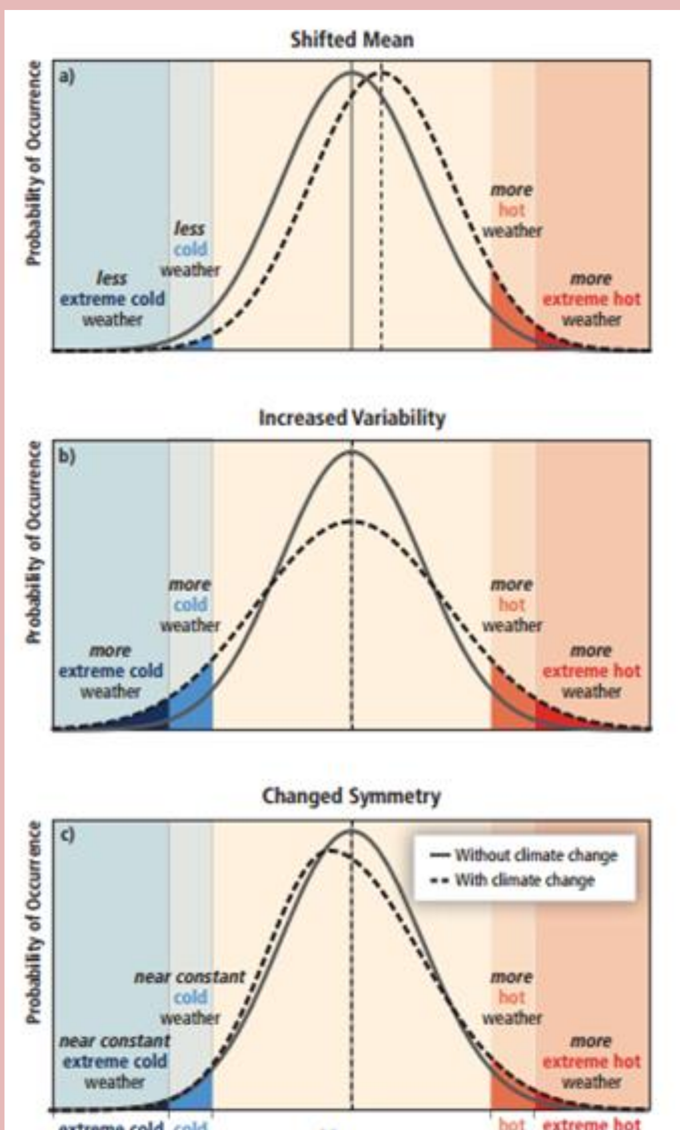
6. Factor uncertainty into risk analysis, communication, and decision processes.

Users of EWS will lose faith in the information provided if uncertainty is not effectively communicated. For information at a long lead-time, e.g., near the start of the growing season, uncertainty of early warning information should be factored into communication, in probabilistic terms. For determining appropriate responses, cost benefit analysis can incorporate uncertainty and be used to set thresholds for action.

Climate change and low-frequency natural variability in the climate system cause the baseline risk to change over time. This should be factored into processes to calibrate early warning systems, to characterize accuracy of the information, and to communicate current risks to users in the context of any evidence of trends in climatic drivers of risk. Presenting historic time series of the early warning variables can help decision-makers interpret current information in the context of historic variability, and any trends in the relevant risks to food security.

Box 5: Increase in Extremes

The effect of changes in temperature distribution on extremes. Different changes in temperature distributions between present and future climate and their effects on extreme values of the distributions: (a) effects of a simple shift of the entire distribution toward a warmer climate; (b) effects of an increase in temperature variability with no shift in the mean; (c) effects of an altered shape of the distribution, in this example a change in asymmetry toward the hotter part of the distribution (Source: IPCC 2012)



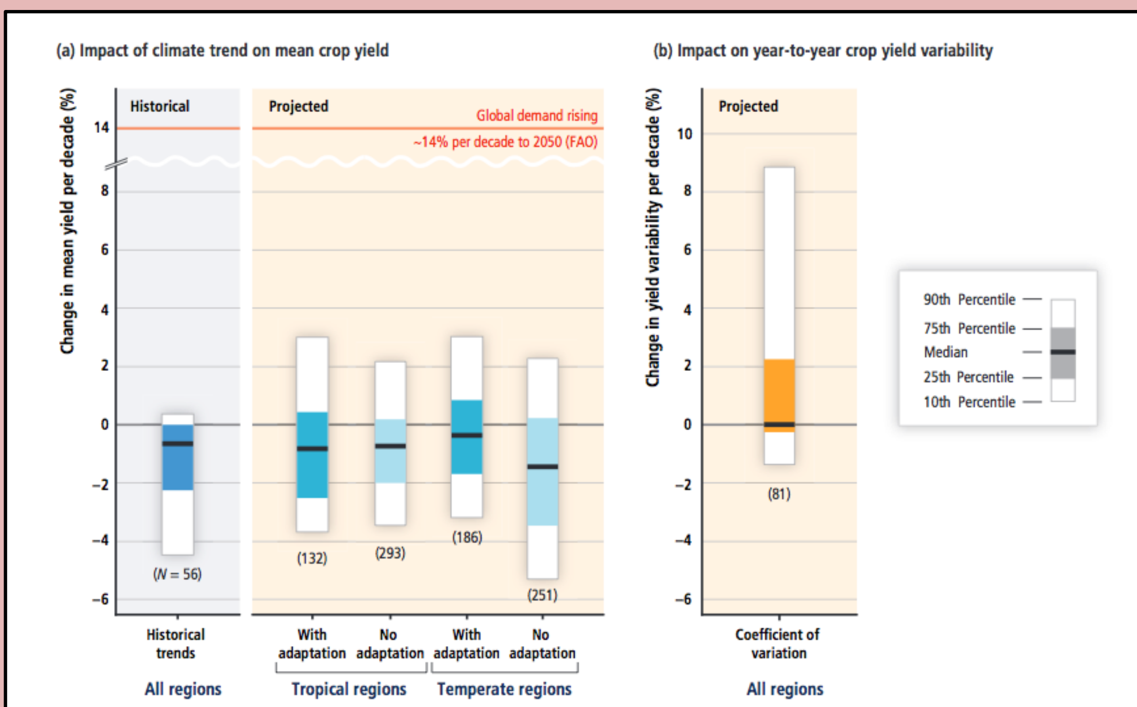
Increasing Climate Variability

In the past three decades we have experienced a warming trend not seen since the 1850s, as well as natural decadal and interannual variability (ARC5, 1). The UNFCCC distinguishes between this "natural variability" based on observations at different time scales (IPCC, 49), and "climate change," the long-term trends attributed to human activity (IPCC, 5). Increased natural variability contributes to many extreme weather and climate events and is an important component in the study of future extreme events (IPCC, 7). Extreme events are defined as "the occurrence of a value of a weather or climate variable above (or below) a threshold near the upper (or lower) ends of the range of observed values of the variable" (IPCC, 30). Communities can be vulnerable to both climate change and variability and employ strategies to adapt to the various resulting effects (IPCC, 87). Because these events can occur and/or recur over a broad range of time scales, discussion of risks, disasters, and adaptation strategies must consider both climate variability and climate change.

Increased drought and rainfall events are among the ways in which climate change and variability impacts people's livelihoods (AR5, 55). With medium confidence, droughts are expected to increase in currently dry regions (AR5, 74), although rainfall patterns have been changing over time (IPCC-A, 3). For example, over the last 30-60 years, overall rainfall amounts have decreased over western Africa, but some assessments indicate that eastern Africa may have more intense rainy seasons and milder droughts by the end of the century (IPCC-A, 3). Urban areas lacking the necessary infrastructure to withstand these events are at risk of experiencing negative impacts to local economies, livelihoods, and ecosystems (AR5, 75). In rural areas, the climate impacts may affect food security and water availability, especially for disproportionately poor and disadvantaged populations (AR5, 75). Evidence of these rainfall trends highlights the need for adaptation measures for building resilience (IPCC-A, 3).

Many developing countries' economies rely heavily on agriculture, especially smallholder and subsistence farming. The agriculture sector has a close link to climate, so it will likely be greatly impacted by extreme climate and weather events (IPCC, 235). Already the overall warming trend has led to a decrease in crop yields, both from flooding and drought associated with wetter and drier seasons. Not only does this rainfall and temperature variability affect the growing season, but through harvest can also affect the crop quality (IPCC, 247) as has already been seen in Cameroon (IPCC, 253), Cambodia (IPCC, 255), and North America (IPCC, 259). Adaptation measures and disaster management strategies are already in place in many areas, but a major challenge is the capacity to respond to information (IPCC, 75). Early warning systems have helped reduce exposure to extreme events (IPCC, 89) but communication of information has required continual improvement (IPCC, 95).

Box 6: ***Projected Increase in Crop Variability***



Boxplot summary of studies that quantify impact of climate and CO2 changes on crop yields, including historical and projected impacts, mean and variability of yields, and for all available crops in temperate and tropical regions. (Source: AR5)

Food Security Early Warning Systems

Famine is a well-understood occurrence, and by observing trends can be fairly well anticipated. Shocks such as droughts, successive failed rainy seasons, and poor harvests drive populations in the "hunger gap" (Bailey, 11), wherein people must employ coping strategies, such as foraging, leading to a decline in trade and economic well-being. Eventually, though it can be challenging to measure, the tipping point is reached at which malnutrition and mortality rates increase quickly; this is a "livelihood crisis" (Bailey, 12). Agencies consider it a humanitarian emergency when the population's coping mechanisms are not enough to stave off mortality and morbidity.

If communities at the local, national, or trans-national scale were to respond at the hunger gap stage, the livelihood crises could be addressed through actions targeted to that particular population, such as water point rehabilitation and veterinary care. When the crisis becomes a humanitarian emergency, it is too late for these targeted actions. At this point, national budgets are strained and tapped of essential resources, and in some cases aid agencies and donors are requested to provide food, cash, and emergency health services.

Early warning systems should be able to predict both livelihood and humanitarian crises. The systems may vary according to the needs and capabilities of different environments and local infrastructure, but certain elements remain the same: data collection, analysis for early warning information, then communication to decision-makers. Early warning risk factors include weather and climate data, harvest yields, and market fluctuations. Analysts observe these data over time, and develop tools, such as a crisis calendar, to track and determine which interventions and actions would be most appropriate at any given time.

Early warning systems take different forms depending upon the geographical scope. At the international level, UN agencies and international NGOs utilize the Famine Early Warning System Network (FEWSNET), a consortium of agencies, ministries, and organizations funded by USAID which provides regular and specialized reports and alerts based on a vast body of research. At the regional level, governments may come together to monitor risks and coordinate responses to be executed at a more local level, as with the Inter-Governmental Authority for Development (IGAD) in the Horn of Africa. Niger and Ethiopia each have early warning systems at the national level, monitoring data within their own borders and reporting upon the state of national food security to the central government. Finally, on the community level, early warning systems – often provided by a third party such as an NGO – allow for the sharing of information within a very small area. For example, a drought early warning system in Kenya comprises a few neighboring villages who communicate via radio to share information about water availability, livestock health, disease, etc.

Climate Smart Agriculture and Early Warning

Climate Smart Agriculture (CSA) represents a set of approaches for meeting the challenges posed by climate change within the broader context of an increased demand for agricultural production with a limited set of resources. As noted in the previous section, for Africa this includes projected increases in extreme drought and flood events, along with long-term climate trends toward increased temperature. Projections suggest a decrease in crop yield potential as a result of climate change and research shows that crop yields over the past few decades have already decreased due to warming. Despite these changes, Africa will have to increase the amount of food it produces to meet growing demand. It must do so with little land for expansion, as well as maintain the ecological balance necessary for sustainable cropping systems.

CSA initiatives are responding to these constraints by bringing together a broad set of researchers and practitioners to understand current climate smart agricultural practices to advance research toward future practices. CSA also seeks to support transitional changes in agricultural production systems that are necessary to reduce vulnerability and build resilience to climate change. While specific agricultural technologies are an important part of CSA, it also includes engagement in policy processes, governance, and information systems that create an enabling environment for climate smart agricultural practices to thrive.

Effective early warning systems play a key role within the CSA framework. While a goal of many CSA interventions is to increase the capacity for farmers to adapt to change, an effectively linked early warning system provides warning when the capacity to adapt is overwhelmed by an extreme event. This requires an information system that is closely tied to current agricultural practices and is responsive to thresholds at which systems are overwhelmed. As agricultural systems innovate and respond to change, early warning systems should include mechanisms that couple changes in practice on the ground with changes in analysis. The early warning information must also reach appropriate agricultural decision-makers at a time when the information can lead to positive action. Further, the format of the information must be understood and trusted by users at local levels. Research on climate smart agriculture can provide informative analysis for early warning systems and increase current understanding of thresholds for a wide range of agricultural systems that exist today or will be part of CSA initiatives in the future.

Conclusion

Extreme climate events can undermine agricultural and rural development progress. Even in years when extreme events do not occur, the uncertainty that results from climate-related risk is an impediment to sustainable intensification of agriculture and adoption of climate-smart agricultural production practices. Systems that provide early warning of climate extremes can reduce the adverse impacts of such events – if they are embedded in effective communication and linked to decision-making processes. However, there is general consensus that early warning systems are not meeting their current potential to provide decision-makers with timely information in a format that enables action. Recent failures to respond effectively to slow-onset extreme climate events – particularly drought – have generally been attributed to failures in decision-making rather than failures in early warning. Therefore any investment in developing or improving early warning systems should be coupled with investment in improving communication and decision-making processes to maximize the benefit of early warning. In order to increase response, early warning systems must also tailor information for a broader set of actors ranging from global to community level. Many institutions create early warning systems for their own operational purposes or share warnings broadly without regular feedback from stakeholders. Making appropriate early warning information available to decision-makers at a more local level can allow earlier, better targeted mitigation action that may reduce long-term impacts of climate shocks on livelihoods, and reduce the need for emergency assistance later. Such an approach would require increased capacity at local levels and regular feedback to assure that the information provided is keeping pace with local dynamics.

Authorship and Acknowledgement

This submission was prepared by:

- Kevin Coffey, CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS), Cali, Colombia; and International Research Institute for Climate and Society, Earth Institute, Columbia University
- Menghestab Haile, World Food Programme, Cairo, Egypt
- Mea Halperin, International Research Institute for Climate and Society, Earth Institute, Columbia University
- George Wamukoya, COMESA - Common Market for Eastern and Southern Africa, Nairobi, Kenya
- James Hansen, CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS), Cali, Colombia; and International Research Institute for Climate and Society, Earth Institute, Columbia University
- James Kinyangi, CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS), Cali, Colombia; and International Livestock Research Institute (ILRI), Nairobi, Kenya
- Kindie Tesfaye Fantaye, CIMMYT - International Maize and Wheat Improvement Center, Addis Ababa, Ethiopia

References:

Aker, J. C. (2008). Droughts, grain markets and food crisis in Niger. *Available at SSRN 1004426*.

Bailey, R. (2012). *Famine Early Warning and Early Action: The Cost of Delay*. Royal Institute of International Affairs.

Bailey, R. (2013). *Managing Famine Risk: Linking early warning to early action*. Royal Institute of International Affairs.

CDKN (2014) Fifth Assessment Report: What's in it for Africa?

Dinku T, Block P, Sharoff J, Hailemariam K, Osgood D, del Corral J, Cousin R, Thomson MC (2014) Bridging Critical Gaps in Climate Services and Applications in Africa. Earth Perspectives 1:15

Devereux, S. (2007). The impact of droughts and floods on food security and policy options to alleviate negative effects. *Agricultural Economics*, *37*(s1), 47-58.

Field, C. B. (Ed.). (2012). *Managing the risks of extreme events and disasters to advance climate change adaptation: special report of the intergovernmental panel on climate change*. Cambridge University Press.

Haile, M. (2005). Weather patterns, food security and humanitarian response in sub-Saharan Africa

IPCC. (2012). Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation. A Special Report of Working Groups I and II of the Intergovernmental Panel on Climate Change [Field, C.B., V. Barros, T.F. Stocker, D. Qin, D.J. Dokken, K.L. Ebi, M.D. Mastrandrea, K.J. Mach, G.-K. Plattner, S.K. Allen, M. Tignor, and P.M. Midgley (eds.)]. Cambridge University Press, Cambridge, UK, and New York, NY, USA, 582 pp.

IPCC. (2014). Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, R.K. Pachauri and L.A. Meyer (eds.)]. IPCC, Geneva, Switzerland, 151 pp.

Lautze, S., Aklilu, Y., Raven-Roberts, A., Young, H., Kebede, G., & Leaning, J. (2003). Risk and Vulnerability in Ethiopia: Learning from the Past, Responding to the Present. *Preparing for the Future*.

Lautze, S., Bell, W., Alinovi, L., & Russo, L. (2012). Early warning, late response (again): the 2011 famine in Somalia. *Global Food Security*, *1*(1), 43-49.

Pauw, K., & Thurlow, J. (2009). Economic losses and poverty effects of droughts and floods in Malawi. *International Food Policy Research Institute (IFPRI), Washington*.

Webb, P., Von Braun, J., & Yohannes, Y. (1992). *Famine in Ethiopia: policy implications of coping failure at national and household levels* (Vol. 92). Intl Food Policy Res Inst.

World Bank. (2013). Building Resilience: Integrating climate and disaster risk into development. Lessons from World Bank Group experience. The World Bank, Washington DC.