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Climate change and nutrition in Africa

With a focus on Sub-Saharan Africa

Tirado, M.C.^{a,b}, Crahay, P. ^c, Hunnes, D. ^a, Cohen, M. ^d, (Denton, F. ^e, Lartey, A. ^f)

^a University of California-Los Angeles School of Public Health, Los Angeles, CA, U.S.A.

^b Public Health Institute, Center for Public Health and Climate Change, Oakland, CA, U.S.A.

^c Action Contre la Faim | ACF International, Scientific and Technical Department, Paris, France.

^d Oxfam America, Washington D.C., U.S.A.

^e International Development Research Center, Senegal (reviewer).

^f University of Ghana, Department of Nutrition, Ghana (reviewer).

1. Introduction

Climate change represents a major threat for the coming decades, particularly in Africa which has more climate sensitive economies than any other continent. Some regions in Africa have become drier during the last century (e.g, Sahel) and it is projected that the continent will experience a stronger temperature increase trend than the global average (Boko et al. 2007). Africa has often been identified as one of the most vulnerable regions to climate variability and change because of multiple stresses and low resilience, arising from endemic poverty, weak institutions, as well as recurrent droughts and associated complex emergencies and conflicts. Climate-related risks have significant impacts on African populations and economies and drive large allocations to emergency resources.

Climate change exacerbates the existing undernutrition problem in Africa and will further undermine current efforts to reduce poverty and undernutrition, particularly in Sub-Saharan countries. Undernutrition in turn undermines the resilience of vulnerable populations decreasing their ability to cope and adapt to the consequences of climate change and their ability grow economically. The current drought in the Horn of Africa that triggered famine in Somalia and spurred food crises in others countries is likely an indication of what may come as such incidents become more commonplace, with extreme weather events having a higher probability of occurring as a result of climate change.

The objectives of this paper are to:

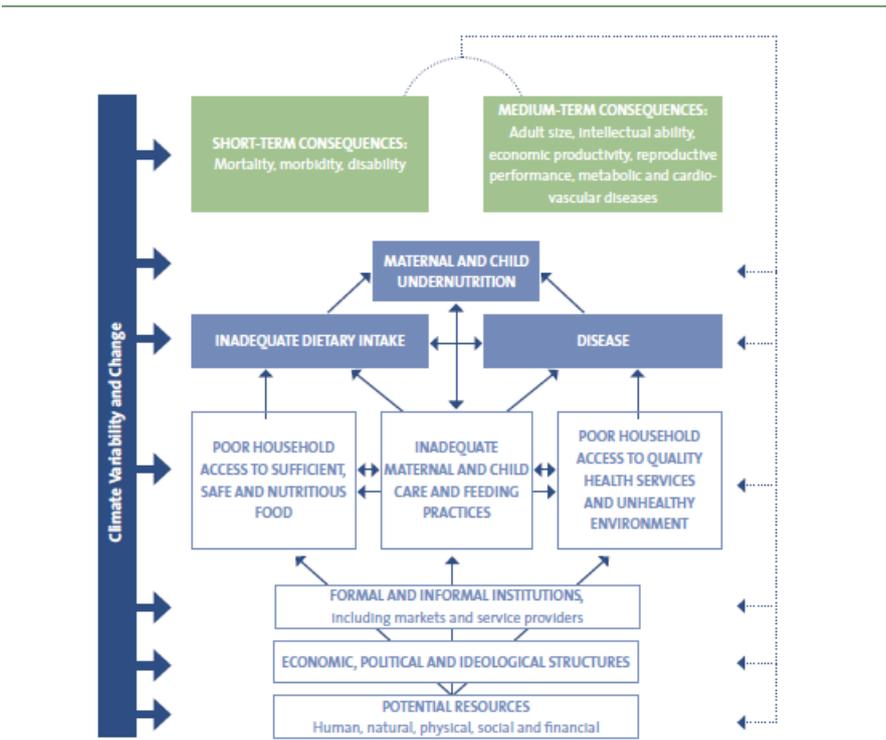
- (1) Review the existing research and information on the impacts of climate change and variability on nutrition security in Africa and the adaptation and mitigation strategies to address these challenges, with a particular focus on Sub-Saharan countries.

- (2) Identify the research needs for the nutrition and related sectors to effectively address the impacts of climate change on nutrition security in Africa in the next 10-15 years.

2. Methodology – Framework for the analysis of climate change challenges to food and nutrition security

A review and analysis of existing literature was conducted to identify the existing research gaps and needs on the impacts of climate change on nutrition security in Africa, and on the adaptation and mitigation strategies to address these challenges. This literature review was guided by a comprehensive analytical framework presented in the figure 1 below. Our review particularly focused on the three ‘underlying causes’ of undernutrition, i.e. household food access; maternal and child care and feeding practices; and environmental health and health access and their linkages with climate change impacts, vulnerabilities, adaptation and mitigation.

FIGURE 1 | FRAMEWORK FOR ANALYSIS OF CLIMATE CHANGE CHALLENGES TO NUTRITION SECURITY



Our analytical framework has been adapted from the frameworks of UNICEF (1991) and Black et al. (2008). It recognizes that poor household access to sufficient, safe and nutritious food; inadequate maternal and child care and feeding practices; and poor household access to health services and unhealthy environment are the underlying causes of maternal and child undernutrition (including both chronic and acute malnutrition) in developing countries. The framework further identified basic causes of undernutrition including environmental, economic and socio-political contextual factors, with poverty playing a central role. The framework also acknowledges that shocks, trends and seasonality have considerable effects on undernutrition and its causal pathways. Climate variability and change considerably influence shocks, trends

and seasonality that observed and predicted in Sub-Saharan African countries, and that represent sources of stresses in the lives and livelihoods of exposed communities.

It is important to stress that so far, there is no broadly accepted and comprehensive analytical framework for the analysis of the impacts of climate change on nutrition security. The framework used for this analysis (Figure 1) likely represents a suitable framework to analyse in a comprehensive manner the multiple linkages between climate change and nutrition security. This framework should be further strengthened along with an appropriate set of nutrition-sensitive indicators in the future.

Key terms used in the paper related to climate change and nutrition are included in Annex 1.

3. The impacts and threats of climate change on food and nutrition security in Africa

Climate change represents a major threat to development and food security for the coming decades (Pachauri and Reisinger, 2007). Climate projections for Africa suggest that the continent will experience a stronger warming trend than the global average (Boko et al., 2007).

3.1 ENVIRONMENTAL IMPACTS OF CLIMATE CHANGE AND VARIABILITY IN AFRICA

Increased temperatures deplete land of its moisture more rapidly and can lead to regional water scarcity, salinization of agricultural lands, and to the destruction of crops. As temperatures increase, precipitation is becoming more variable over most of Africa. For some regions, rainfall variability and unpredictability has been substantial in the past forty to fifty years. According to Boko et al. (2007) there has been an overall annual decline in rainfall observed since the end of the 1960s over Africa with some regions experiencing greater declines than others. For instance, the Sahel and Southern Africa have become drier during the twentieth century.

By the 2080s, the area of arid and semi-arid land in Africa will likely increase by 5-8% (IPCC, 2007). The population at risk of increased water stress in Africa is projected to be between 75-250 million and 350-600 million people by the 2020s and 2050s, respectively (Boko et al., 2007).

Seasonality represents an important source of stress in the lives and livelihoods of poor rural communities (Devereux et al, 2008). There are some indications that seasonality is changing as well in Africa in the scientific literature (e.g. Boko et al., 2007). These changes can be either positive (increased precipitation) or negative (e.g. shorter rainy seasons). African farmers and herders extensively reported changes in seasonality; for example, rainfall is reported to be more erratic or shorter as illustrated in Oxfam publication 'What happens to the seasons?' (2009). Changes in seasonality influence livelihoods, food production, access to water, disease patterns, and ultimately the 'seasonal peak' of undernutrition (ACF, 2008. Seasons of Hunger).

Data from the international disaster database 'EMDAT' suggest that the total number of African people affected by droughts or floods has been steadily increasing since throughout the past decades. Drought will continue to be a primary concern for many African populations.

TABLE 1 | PEOPLE AFFECTED BY DROUGHTS AND FLOODS IN AFRICA THROUGHOUT THE 3 PAST DECADES

Total number of people in Africa affected by	1980-89	1990-1999	2000-2009
Droughts	89,256,067	92,234,246	158,508,578
Floods	5,583,456	14,358,269	23,331,733

Africa is particularly vulnerable to the effects of climate change because of multiple stresses and low adaptive capacities, arising from endemic poverty, complex governance and institutional dimensions; limited access to capital, including markets, infrastructure and technology; ecosystem degradation; and complex disasters and conflicts (Boko et al., 2007; UNISDR, 2008). These in turn have contributed to Africa’s weak adaptive capacity, increasing the continent’s vulnerability to projected climate change. These changes are having a dramatic impact on food and nutrition security and health in Africa, and in particular, sub-Saharan Africa (NOAA, 2011; Boko et al., 2007; Oxfam International, 2010).

Environmental changes as consequences of climate change and others human-induced factors will exacerbate migration processes and might increase the likelihood of tensions or conflicts over natural resources. Migration, climate change, and the environment are interrelated and have an impact on hunger and nutrition security (FAO, 2008).

3.1. CLIMATE CHANGE AND VARIABILITY IMPACTS ON NUTRITION SECURITY

Changes in extreme weather events, seasonality and others climate variables, along with changes in ecosystems, biodiversity and natural resources will ultimately have considerable effects on the food and nutrition security of African communities, societies and economies, which are closely dependent on rainfall and natural resources for their lives and livelihoods. These changes in climates and environments will force households and institutions to adapt their livelihood strategies and diversify their asset base to survive and thrive.

Climate change and undernutrition in Africa

As per our literature review, very few studies analyse in a comprehensive manner the impacts and threats on undernutrition and nutrition insecurity in Africa. In the other hand, predictions on the additional climate change-induced caseload of stunted or wasted children (or other population groups) were almost inexistent in the literature. Quantifying this problem remains a complex exercise, because of the cross-sectoral nature of undernutrition. The most interesting data were provided by The International Food Policy Research Institute (IFPRI), which stated that ‘calorie availability in 2050 is likely to decline throughout the developing world resulting in an additional 24 million undernourished children (0-5 years), 21% more relative to a world with no climate change, almost half of which would be living in sub-Saharan Africa (Nelson et al, 2009; Parry et al, 2009)’; refer to the Figure 2. Nelson et al (2009) also stated that climate change will eliminate much of the improvement in child malnourishment levels that would occur with no climate change.

It is important to note that IFPRI has considered only two indicators for such predictions: per capita calorie consumption and child malnutrition numbers. Given the multiple causes of malnutrition, this figure represents a conservative estimate, and thus, a 20 % increase in child malnutrition may be reached much more rapidly, or in other terms, the expected increase in malnutrition in 2050 could be much more considerable (Crahay et al, 2010). In addition, Butler (2010) highlighted that 'in reality, the increase in the prevalence of undernutrition will be higher [than the IFPRI' estimations], because this result refers only to the cohort of children born between 2045 and 2050; many children born before (and after) these dates will also be malnourished (due to climate change), and many will still be alive (in, say 2050); the adverse consequences of undernutrition in the first years of life are in fact often irreversible (Victora et al. 2008). We could also argue that IFPRI' estimation represents only a 'snapshot in time'; an estimation of the cumulated number of 0-5 years children malnourished as a result of climate change between 2020 and 2050 would lead to even more alarming predictions than IFPRI' estimations.

The IPCC notes that undernutrition linked to extreme climatic events may be one of the most important consequences of climate change due to the very large number of people that may be affected (Confalonieri et al, 2009). For instance in Ethiopia and Kenya, two of the world's most drought-prone countries, studies have found that children aged five or less born during a drought are respectively 36 and 50 per cent more likely to be malnourished than children not born during a drought (Watkins K., 2007). In Niger, children aged two or less born in a drought year were 72 per cent more likely to be stunted (Watkins K., 2007).

Climate change, agriculture and food security in Africa

According to the IPCC, if current trends continue, it is estimated that 200–600 million more people will suffer from hunger by 2080 (Yohe et al, 2007). Climate change-related hunger is particularly a challenge in Sub-Saharan Africa. In fact, the livelihoods of an important proportion of African populations depend on climate and environmental factors (e.g. in sub-Saharan Africa, rain-fed agriculture covers 96% of all cultivated land (FAO, 2007). Natural resource-based livelihoods are sensitive to climate-related shocks (e.g. droughts and floods) and changes in rainfall, natural resources or seasonality. Lots of poor communities are already striving today to cope with existing climate variability – such as illustrated by the current drought in the Horn of Africa.

Agricultural production and food security in many African countries and regions are likely to be further and severely compromised by climate change, affecting particularly smallholder farmers and herders. Changes in rainfall patterns are hard to predict, but all the combined effect of droughts, floods, poor water infrastructure, and increasing temperatures, and rising waters in the sub-Saharan Africa region, are predictive of decreasing agricultural production, increased food prices, and loss of livelihoods, increasing food and nutrition insecurity (NOAA, 2011; Boko et al., 2007). The IPCC (2007) and Boko et al. (2007) project that reductions in crop yield in some sub-Saharan countries could be as much as 50 per cent by 2020. Crop net revenues could fall by as much as 90% by 2100 in some regions (Boko et al., 2007).

Food prices are influenced by climate variability, extreme weather events, or major civil disturbances, among other factors (Godfray, 2010). The frequency and severity of production shortfalls are projected to increase due to climate change, thereby increasing food prices even further (DFID, 2009). Food price increases will be either localised or take place at global scale; countries that rely on food imports are expected to be badly hit by global food price rises, as already experienced in 2008 and 2010. For the majority of African poor households who spend a high proportion of income on food, price spikes have adverse effects on their food intake and nutrition security.

It is important to highlight that climate change is one stressor among others. Small-holder agriculturalists are especially vulnerable to a range of social and environmental stressors. These may include: population increase driving fragmentation of landholding; environmental degradation stemming from population poverty, ill-defined property rights; regionalized and globalized markets, market failures and barriers to exportation; and continued declines and unpredictability in food prices and in the prices of many major agricultural commodities of developing countries.

Climate change, maternal and child care and feeding practices in Africa

Despite the fact that maternal and child care practices are critical factors that influence the prevalence of undernutrition, very few literature was found on the potential effects of climate change on these practices.

It is expected that these effects will have considerable implications for maternal and child undernutrition in Africa. In fact, climate change will put further strain on the already heavy workload of women (CIDA, 2002) – for instance by increasing water stresses and the time dedicated to fetch water for domestic purposes (Parikh and Denton, 2002) or as a consequence of forced displacement. In Sahel and in the Horn of Africa, men commonly migrate during periods of drought, leaving the women alone to look after their children, work in the fields, tend the herds and manage the home. This can compromise their ability to provide proper care to infants, heightening the risk of undernutrition (Crahay et al, 2010). It is important highlighting as well that increased ‘time poverty’ could also significantly reduce women’ opportunities to engage in income-generating activities, with knock-on effects on household food and nutrition security (Masika, 2002; FAO, 2006).

Climate change and health in Africa

According to the Lancet (Costello et al, 2009), climate change is the biggest global health threat of the 21st century. It will further negatively impact human health in Africa, already compromised by a range of factors. Climate change will contribute to increased disease, morbidity and malnutrition, and increased mortality in Africa, through various pathways.

Climate change will increase the frequency and severity of droughts, floods and storms leading to an increase number of people suffering from death, injury, disease (based on Confalonieri et al, 2007) and undernutrition. HIV/AIDS is amplified during drought as malnutrition increases the risk of acquiring and of dying from an infectious disease.

Climate change will alter the ecology of some disease vectors in Africa, and consequently the spatial and temporal transmission of such diseases. The most famous examples relate to changes in the areas with malaria prevalence (such as in southern Africa and the East African highlands); however there are still debates on the attribution of malaria resurgence in some African areas. Whereas research on malaria prevalence and climate change is relatively abundant, other infectious diseases – such as dengue fever, meningitis and cholera, among others – would deserve more attention (Boko et al., 2007). It is interesting to also note that warmer seas may increase harmful algal blooms, which produce toxins that can cause human disease such as human shellfish poisoning.

High temperatures and climate change-related alterations in rainfall, surface water availability and water quality will in fact impact on the incidence of water-related diseases (Confalonieri et al., 2007). Extreme rainfall/runoff events and floods, in conjunction with warmer temperatures, may also serve to increase the total microbial load in watercourses and drinking-water reservoirs (Confalonieri et al., 2007). The lack of access to safe drinking water and sanitation overwhelmingly affects the health and feeding practices of women and children; water-related diseases – particularly diarrhoeal diseases, but not only – directly affect the absorption of nutrients by the human body, thus exacerbating undernutrition.

Rural-to-urban environmental and forced migration processes might increase communicable disease and poor nutritional status from overcrowding, a lack of safe water, food, and shelter, and ability to access food (Confalonieri et al., 2007).

4. Analysis of research initiatives and gaps in Africa on nutrition security, adaptation and mitigation

This section reviews the existing research addressing the impacts of climate change and variability on nutrition security and related adaptation and mitigation initiatives in Africa. It suggests key research gaps based on our review of the literature. Last it provides illustrations of initiatives that address nutrition security and adaptation or mitigation. This review considers nutrition and the three main pillars of nutrition security, i.e. food security; maternal and child care and feeding practices; and health. These pillars related to the causal pathways presented in the framework of the Figure 1.

4.1. CLIMATE CHANGE ADAPTATION AND NUTRITION SECURITY

Human or societal adaptive capacity, identified as being low for Africa by the IPCC Third and Fourth Assessment Reports, is progressively better understood, and this understanding is supported by several case studies of both current and future adaptation options.

Adaptation to climate variability and change is a requirement for future sustainability of agriculture and food security, and of health and nutrition in sub-Saharan Africa. It is important to emphasize that adaptation to current climate variability can increase the resilience of countries to long-term climate change (Adger et al., 2007), at a time when many countries and communities are not able to address existing climate variability (e.g. such as illustrated by the severe drought impacts at present in the Horn of Africa). Within adaptation, a number of

strategies are used that fall within nutrition; agriculture and food security; maternal and child care and feeding practices; health, including environmental health and water and sanitation. The initiatives that fall into each of these categories represents adjustments or projects that individuals, groups, and countries are making to moderate harm from climate variability and change on food and nutrition security. It is important emphasizing that tackling the negative effects of climate change on nutrition security require an integrated approach that combines these strategies.

Nutrition-specific initiatives

Whereas some insights on climate change, nutrition and adaptation exist at global level, we couldn't find any research initiatives that seek to better understand how to tackle climate change-related effects on nutrition and nutrition security in Africa during our literature review. This is of particular concern considering the observed and predicted impacts of climate change on nutrition in this continent. A likely explanation is that, so far, the nutrition stakeholders remain disconnected from climate change-related agendas and initiatives, and vice-et-versa.

We identify the following themes as critical research gaps:

- Conducting comprehensive, multi-sectoral analyses of the impacts of climate change on nutrition and nutrition security at the level of the African continent, regions and countries, and highlighting the existing coping mechanisms and the adaptation options.
- Developing and improving prediction models on the impacts of climate change on undernutrition and nutrition insecurity in Africa – along with economic analyses of the resulting impacts in terms of lost national productivity and economic growth.
- Identifying and mapping geographical zones – at the level of the African continent – that are particularly vulnerable to the negative effects of climate change on nutrition ('climate and undernutrition hotspots').
- Developing or strengthening national and sub-national monitoring systems that combines climate-related data (such as rainfall), undernutrition prevalence and variables related to nutrition insecurity (in priority: (i) in those areas with high undernutrition prevalence and high sensitivity to climatic fluctuations and (ii) in 'climate and undernutrition hotspots').
- Identifying, validating and budgeting the set of interventions required to protect nutrition from climate-related risks.

Most nutrition-specific activities – such as those highlighted in the 2008 Lancet series or the 2010 Scaling Up Nutrition framework of action – build the resilience of individuals at-risk in face of climate change effects, *but as well in face of others non-climatic shocks and stresses* (e.g. high food prices). These nutrition-specific activities also address the *consequences* of climate shocks and stresses in Africa. However, very few nutrition initiatives *specifically* consider and strategically address climate change-related impacts and threats on undernutrition. Current initiatives that bridge undernutrition with existing climatic fluctuations or climate variability could pave the way for nutrition-specific initiatives in a changing climate. An example is the Integrated Phase Classification (IPC) monitoring and early warning system, which is established in the Horn Africa and others parts of the African continent.

Agriculture, food security and nutrition

There is a rather large number of research projects conducted on 'climate change, adaptation/resilience building, agriculture and food security', e.g. in the frame of:

- The Climate Change, Agriculture and Food Security research initiative of the CGIAR;
- The Climate-Smart Agriculture initiative of the FAO;
- The multiple initiatives of the Climate Change Adaptation in Africa (CCAA) program piloted by the International Development Research Centre (IDRC);
- The emerging Adaptive Social Protection in the Context of Agriculture and Food Security programme (ASP Programme) funded by DFID and led by the Institute of Development Studies (IDS) in the Horn of Africa (among others).

These initiatives aim at enhancing food security, while adapting to climate variability and change, reducing risks and build resilience, and sometimes while also reducing greenhouse gas emissions (for agriculture-related research projects and initiatives). It is useful to remind that not all agricultural development initiatives lead to positive nutrition outcomes. In Kenya and in the Philippines, for example, the adoption of cash crops expanded food supply and doubled the household incomes of small farmers, but 2006 studies showed that children's energy intake increased only from 4 to 7 per cent, and that child undernutrition was little changed (Hawkes, C., ed. and M. T. Ruel, eds., 2006). Nutrition remains a subordinate theme in the climate change, agriculture and food security research agenda, and this despite the fact that promising research projects are developed at present to better bridge the agriculture, health and nutrition agendas – such as the recent initiative of the International Food Policy Research Institute (IFPRI) initiative. Nutrition remains also quite subordinate in the 'climate change, risk management/social protection and food security' agenda.

We identify the following themes as critical research gaps:

- Identifying strategic and efficient ways to enhance the nutrition 'footprint' among existing research initiatives on climate change and food security, and exploring existing opportunities (e.g. better linking the 'climate change, agriculture and food security' research agenda with the 'agriculture, health and nutrition' research agenda).
- Analysing and monitoring the nutritional outcomes of respectively (i) existing 'climate change, agriculture and food security' initiatives and (ii) 'climate change, risk management/ social protection and food security' initiatives, and recommending nutrition-sensitive improvements to these initiatives.
- Analysing the climate change effects on dietary diversity and the related adaptation options.

Climate change, agriculture and food security projects tend to induce tailored adaptations to agricultural systems and practices in order to maintain or enhance productivity under changing conditions. This can involve the application of new technologies, new land management techniques or water-use efficiency related techniques. Examples of these types of projects include seasonal changes and sowing dates; developing varieties that are more resistant to specific climatic conditions (e.g. droughts, floods); adaptations in water and irrigation system; promotion of agroecology and agroforestry systems that are more resilient and adapted to changing climates (FAO, 2005; De Schutter, 2010).

Climate change, risk management and food security projects aim to reduce the climate-related risks through early warning mechanisms, enhanced preparedness and risk mitigation strategies. Climate change, social protection and food security projects aim to protect, prevent, promote or transform the livelihoods of at-risk or vulnerable groups via social services, subsidies, cash and food transfers, school feeding, etc.

EXAMPLES

Agroecology, agroforestry, food security and nutrition in Senegal

Moringa Trees are very drought-resistant and tolerate a wide variety of soil types. Once established, a tree can be cut back to ground level and will still grow back. Leaves can also be produced intensively within small backyard or rooftop gardens. Everyone can thus have easy, cost-free access to the product.

Laboratory analysis of fresh and dried leaves have shown that they are a very rich source of vitamins A, C, B-complex and E, as well as iron, calcium, potassium, magnesium and selenium. The leaves also contain all of the essential amino acids, rare among legumes. Finally Moringa trees help to fertilize the soils around them, helping with land management, and increasing crop output.

Risk management, food security and nutrition in Burkina Faso

Burkina Faso's Food Security and Nutrition Project is designed to 1) reduce the government's response time to react to national food crisis, 2) improve the targeting of food security programs for low income groups in drought-prone provinces 3) provide a database for rational decision-making on food security and nutritional issues 4) provide an institutional focal point within the Ministry of Agriculture and Livestock (MOAL) for food security management with an integrated early warning system, income earning opportunities during the dry season, and by targeting nutrition information, education, and communication campaigns for behavioural changes in child weaning and feeding.

Resilience building, micro-insurance, food security and nutrition in Ethiopia

The Horn of Africa Risk Transfer for Adaptation (HARITA) project brings together WFP, Oxfam America, Ethiopian farmers, the global reinsurance company Swiss Re, the Relief Society of Tigray (REST), the International Research Institute for Climate and Society at Columbia University, Nyala Insurance, the Ethiopian Federal Ministry of Agriculture and Rural Development, and several other organizations. It contributes to resiliency for smallholder farmers based on a combination of agroecological farming technologies, drought insurance, and credit. The scheme reaches the poorest farming families in Adi Ha, Tigray Region, through a premium-for-assets program supported by the United Nations World Food Program (WFP) and the Ministry's Productive Safety Net Program. This scheme monetizes the risk-reducing labour of poor farmers into their premiums. Farmers participated in a community-wide vulnerability and capacity assessment and identified lack of rainfall and droughts as the primary hazards to their well-being. They now apply resilience-building and agricultural risk-reducing solutions such as composting, water harvesting, seed washing, and tree and grass planting. Less-poor farmers who do not qualify for the premium-for-work program can pay cash premiums. Payouts are based on indexed meteorological indicators. In December 2010, Oxfam and WFP announced a five-year, \$28 million partnership to scale this model up in other developing countries.

Maternal and child care and feeding practices and nutrition

During our literature review, we couldn't find any research initiatives that seek to better understand the effects of climate change on maternal and child care and feeding practices in Africa and the required responses. This is of particular concern considering that these practices will be substantially affected by climate change. It is important noting that there is already a diverse range of coping strategies implemented among at-risk households and communities throughout Africa. For instance in pastoral communities in southern Ethiopia, women with young children tend to keep a milking cow during the dry season – while men and others livestock are migrating to greener and remote pasture, in order to have a nutritious source to feed their children. For instance in pastoral communities in southern Ethiopia, women with young children tend (when possible) to keep a milking cow along with them during the dry season, while the men and the rest of the herd migrate to greener pasture. This allows to guarantee an important source of nutrients for their young children during these harder times. Too little is known about these 'autonomous' coping strategies in face of adverse climatic events, while these strategies could pave the way for tailored adaptation options.

We identify the following themes as critical research gaps:

- Conducting analyses about the effects of climate change on maternal and child care and feeding practices and the linkages with undernutrition at the level of the African continent, regions and countries
- Highlighting the existing coping mechanisms developed among at-risk households and communities and the required adaptation options.

Maternal and child care and feeding practices and nutrition activities relate to the sensitisation and training of mothers and care-takers, but we couldn't find any such initiative linked to climate variability and change.

Health and environmental health, water and sanitation and nutrition

There are a rather large number of research projects that aim at a better understanding of the effects of climate change on health, environmental health, water and sanitation in Africa, along with the required adaptation responses. Examples include WHO led-initiatives or projects in the frame of the IDRC's CCAA program. In the same way that for the climate change and food security research agenda, nutrition remains a subordinate theme in the climate change, health, water and sanitation agenda.

We identify the following themes as critical research gaps:

- Identifying strategic and efficient ways to enhance the nutrition 'footprint' among existing research initiatives on climate change, health, water and sanitation, and exploring existing opportunities.
- Analysing and monitoring the nutritional outcomes of the climate change, health, water and sanitation initiatives, and recommending nutrition-sensitive improvements to these initiatives.
- Analysing the interlinks between child health status, diseases (particularly water-related diseases) and undernutrition, and highlighting recommendations.

Key initiatives for minimizing health impacts from climate change include: strengthening of public health systems and basic clinical care systems including the availability of essential drugs; enhancing local capacities to address public health emergencies; strengthening surveillance systems of infectious disease; improving the use of early warning systems by the health sector; addressing known environmental risk factors and water-related diseases; integrating nutrition and hygiene education in interventions for the treatment of severe malnutrition, diarrhoeal illness and other common childhood illnesses. Health care access is increasingly important during child malnutrition related to climate-induced migration.

EXAMPLE - Health, environmental, water/sanitation services

The goal of Morocco's Irrigation Based Community Development project is to improve the incomes and the quality of life of rural communities that are centred on small and medium irrigation. This project rehabilitates, improves, and complements community infrastructure, water supplies and sanitation, and health and education facilities to benefit the community. This is a project most geared towards water sanitation and rural infrastructure.

4.2. CLIMATE CHANGE MITIGATION AND NUTRITION SECURITY

Climate change mitigation tackles the causes of climate change, and aims to reduce or minimize the negative impacts and maximize any benefits from future climate change. Mitigation is ultimately designed to stabilize GHG concentrations to prevent (too) damaging anthropogenic interference with the climate system. The IPCC references the Stern Review's findings that to minimize the most harmful consequences of climate change, concentrations would need to be stabilized below 550ppm and that any delay in reducing these emissions is costly and dangerous. In order to prevent the deleterious effects of high GHG concentrations in the atmosphere, a number of mitigation strategies have been proposed, such as reducing CO₂ emissions with improved agriculture technologies; planting of trees and other green-house gas absorbers; development of renewable and alternative energy supplies, etc.

There is a rather large number of research projects conducted in Africa on climate change mitigation, particularly in the energy, agriculture and forestry sectors. However, too little research addresses the potential co-benefits of mitigation strategies and nutrition, despite the fact that many opportunities exist, e.g. in the field of agroecology and agro-forestry. In addition, there is insufficient research on the potential threats of specific mitigation strategies on nutrition security; for instance, specific land-based mitigation strategies might compete with the livelihoods of poor communities and households, hampering their nutrition security.

We identify the following themes as critical research gaps:

- Identifying the promising climate change mitigation strategies that bring co-benefit in terms of nutrition security.
- Identifying the threats that specific climate change mitigation strategies (can) induce on the nutrition security of vulnerable households, communities and countries, and providing recommendations in order to avoid negative knock-on effects of nutrition security.

EXAMPLE - Climate change mitigation projects with multiple objectives in Democratic Republic of Congo

The Tshilenge Svannah, Kasal Oriental carbon sequestration and rural alternative energy in project aims at creating carbon sinks to revalue the marginal soils, provide renewable energy sources, and to create economic activities for the local population. This is an example of sustainable development. This project also supports food production by using residuals from oil extraction as organic fertilizer to be added to soil and applied to maize and other vegetables. These actions not only provide food products, but also provides alternative domestic energy sources while contributing to climate change mitigation..

5. Conclusion and Recommendations

This background paper illustrates that while there has been some research on the impacts of climate change on food security and health in Africa, there is a lack of research on the impacts

climate change on undernutrition and nutrition security, as well as on the adaptation options for nutrition security in Africa.

It has been suggested that a combination of adaptation and mitigation measures, sustainable development, and research to enhance both adaptation and mitigation can diminish the threats to nutrition from climate change (FAO, 2008; Tirado et al. 2010; UNSCN, 2010). Therefore appropriate investment in research initiatives on climate change impacts on nutrition security, on nutrition-focused adaptation and mitigation strategies in Africa are essential. The research and scientific communities have also critical roles in building and validating evidence about successful practices in at-risk communities and countries. This represents an important enabling factor to leverage and scale up adaptation efforts for nutrition security.

5.1. RESEARCH GAPS

Whereas there is a general understanding of some causal pathways leading to undernutrition in the African context, there is no a single study analysing in a cross sectoral manner the impacts of climate change and variability on nutrition security in African countries or in any particular geographical regions in Africa.

IMPACTS

There is a need for adequate prediction models on the impacts of climate change on undernutrition in Africa and worldwide. This has been recognized as one of the critical research needs by the 4th IPCC assessment report. However this is not simple since attribution of current and future climate-change-related undernutrition burdens is problematic because the determinants of undernutrition are complex. Both acute and chronic nutritional problems are associated with climate variability and change. In addition, current models have not been able to incorporate the impacts of extreme weather events and this is a major gap that should be addressed when. Very few nutrition surveillance systems monitor climate-related factors in Africa e.g.; climate-related seasonality and increased undernutrition caseload as a consequence of climate-related shocks. While climate change is expected to have major impacts on maternal and child care, mostly related to forced displacement, there are no data in the literature on the influence of climate change on maternal and child care and feeding practices.

VULNERABILITY

Some sectoral issues that shape nutrition security are overlooked, so is their interplay with undernutrition in the context of climate change. Research and information on the links between climate change related food and water insecurity and malnutrition are necessary.

ADAPTATION STRATEGIES

There is a need to identify and analyse coping strategies for the most vulnerable in sub-Saharan Africa to identify and test nutrition sensitive adaptation interventions to change shocks and their effects on nutritional status.

MITIGATION

Agricultural research can help create new technologies that will facilitate nutrition sensitive agriculture-based mitigation strategies. For example, The FAO has developed climate-smart agriculture approaches that aims at enhancing food security, while adapting to climate change and contributing to climate change mitigation.

5.2. RESEARCH NEEDS ON CLIMATE CHANGE AND FOOD AND NUTRITION SECURITY IMPACTS, VULNERABILITY, ADAPTATION AND MITIGATION IN AFRICA

Several areas of basic and applied research are suggested to better understand and address the impacts and threats of climate change on food and nutrition security in Africa:

ANALYSE FOOD AND NUTRITION SECURITY IN A MULTI-SECTORAL, COMPREHENSIVE MANNER

Although the links between climate change and undernutrition have been increasingly examined recently, most analyses consider isolated pathways such as those of food insecurity, health or water. In others terms, there is an understanding of some causal pathways leading to undernutrition, but no single study offers a comprehensive analysis of the climate change-nutrition security linkages. Comprehensive analyses of observed and predicted climate change-related vulnerabilities and food and nutrition security are non-existent in Africa. It is essential to develop such analyses and the required tools in African rural, peri-urban and urban areas, and in different representative ecosystems and socio-economic contexts. It is particularly important to analyse which regions and populations are particularly vulnerable to climate-related hazards (climate-related shocks; seasonality; trends and gradual changes) and why, and which local coping and adaptation strategies are successful. It will also be necessary to consider how the effects of climate change interact with and exacerbate other phenomena which have major implications for food and nutrition security, such as population growth, HIV/AIDS, food and fuel price volatility, poor governance, conflict, gender discrimination, and adverse global economic arrangements.

STUDY SPECIFIC OVERLOOKED SECTORAL ISSUES AND THEIR INTERPLAY WITH UNDERNUTRITION/NUTRITION SECURITY IN THE CONTEXT OF CLIMATE CHANGE

Whereas the analysis of nutrition security requires a multi-sectoral analysis, specific causal pathways leading to undernutrition in a changing climate are overlooked, i.e. the impacts of climate change on food quality and the crop micro-nutrients contents, on dietary diversity and on maternal and child care and feeding practices; the interlinks between child health status, diseases (particularly water-related diseases) and undernutrition; or the impacts of climate change on the body's nutrient requirements.

PROVIDE CONSISTENT PREDICTION MODEL AND DATA OF UNDERNUTRITION (WASTING, STUNTING, UNDERWEIGHT) IN A CHANGING CLIMATE CONTINENT

It is urgent to develop consistent and realistic models to predict the future impacts of climate change on undernutrition (wasting, stunting, and underweight) under different scenarios. Studies should provide data and information for the attribution of current and future climate change and variability to undernutrition under different scenarios. Economic analyses should

estimate of the resulting impacts in terms of lost national productivity and economic growth based on these predictions, as this represents essential information to decision-makers and donors.

MONITOR THE INTERPLAY BETWEEN CLIMATE-RELATED HAZARDS (I.E. CLIMATE-RELATED SHOCKS, SEASONALITY AND TRENDS) AND FOOD AND NUTRITION SECURITY, AND DEVELOP TAILORED EARLY WARNING SYSTEMS

Climate scientists and researchers should support the food and nutrition security stakeholders in setting up and/ or strengthening nutrition early warning and surveillance systems, integrating (further) the climate dimension. Climate monitoring systems (at various time scales, e.g. seasonal, inter-annual, longer-term) can be better linked to existing food and nutrition security monitoring systems and early warning systems. Enhancing comprehensive early warning systems linked with early food and nutrition security responses mechanisms – particularly in face of climate-related shocks and seasonal hardships – deserve particular attention. It is also important to enhance the capacity of African decision makers to respond to information generated by early warning systems.

IDENTIFY EFFECTIVE ADAPTATION ACTIONS FOR FOOD AND NUTRITION SECURITY UNDER A CHANGING CLIMATE

A knowledge base capitalizing on lessons learnt through experience is necessary to inform future programming on climate change and nutrition, along with the identification, validation and costing (i.e. using cost-benefit analyses) of the set of interventions required to protect nutrition from climate-related hazards and climate change. The development of a response framework for use at multiple levels and different scales for ensuring resilience to climate change and other shocks and food and nutrition security at community and household level is also needed. This response framework should be multi-sectoral and nutrition-sensitive, i.e. identified risk management and adaptation actions have a greater impact in terms of preventing / reducing undernutrition. Ideally this response framework should be adjusted to areas affected by conflict and protracted crises. This response framework should particularly consider the needs of young children and women, since they are the most vulnerable to both hunger and undernutrition and climate change impacts and threats, without neglecting the needs of other groups (adolescents, elderly people).

IDENTIFY STRATEGIC AND EFFICIENT WAYS TO ENHANCE THE NUTRITION 'FOOTPRINT' AMONG EXISTING INITIATIVES ON CLIMATE CHANGE, AGRICULTURE, FOOD SECURITY AND/OR HEALTH

Nutrition remains a subordinate challenge in the 'climate change, agriculture and food security' agenda and in the 'climate change, health, water and sanitation' agenda. It would be important to analyse and monitor nutritional outcomes of the initiatives conducted in the frame of these two agendas, and to explore opportunities for enhanced synergies among the food security, health and nutrition communities of researchers, practitioners and policy-makers.

ANALYSE AND MONITOR THE SYNERGY OPPORTUNITIES AND THE THREATS OF CLIMATE CHANGE MITIGATION MEASURES ON FOOD AND NUTRITION SECURITY

The analysis and monitoring of synergy opportunities and the threats of climate change mitigation measures on food and nutrition security deserve the attention of scientists and researchers. The identification of promising climate change mitigation strategies that bring co-benefit in terms of nutrition security is needed: evidence and recognition that climate change mitigation strategies can have substantial benefits for nutrition security offers the possibility of policy choices that are potentially both cost effective and socially attractive. Suggestions to minimise or avoid potential harmful effects of climate change mitigation measures on food and nutrition security are required.

IDENTIFY HOW TO STRENGTHEN INSTITUTIONAL CAPACITY AND THE POLICY FRAMEWORK IN AFRICA

It is essential to promote policy analysis and research that identify and analyse how climate change work can be better aligned with current agendas, initiatives and policies which aim to reduce hunger and undernutrition at the various level; how to strengthen institutional capacity and the policy framework (e.g. preparedness, horizontal and vertical integration, bottom-up processes, strengthening policies, etc.) and how to ensure policy coherence between food and nutrition security, adaptation and mitigation objectives.

RESEARCH INSTITUTIONS

Regional and research institutions in Africa should incorporate climate change analysis in their programs. The Africa Union Commission and Regional Academies of Science should lead in this effort by coordinating the development of policies for the mitigation of the effects of climate change for adoption by countries. Academies of Sciences can be “think tanks” that provide advice and support to governments on the management of the effects of climate change. Conferences on climate change and nutrition organized under the auspices of professional scientific associations and regional academies of sciences will keep the focus on the problem.

Regional Centres for the study of Climate change impact and analysis must be created within the Sub Saharan Africa region for building the capacity of Africans and for sustaining research on climate change issues. Universities should develop programs and courses to introduce and sensitize students on climate change issues. Climate change analysis should factor into the design, implementation, and evaluation of all food and nutrition security projects and research programs. The participation of African experts and researchers on the work of the Intergovernmental Panel of Climate Change (IPCC) should be encouraged and facilitated.

INVESTING ON A RESEARCH AGENDA

Adequate investment and financial mechanisms are crucial to support a research agenda to address Climate Change and Nutrition in Africa for the next 10-15 years. Climate Funds, investments and national climate adaptation plans should ensure adequate financial allocations for research of nutrition impacts of climate change in Africa and nutrition sensitive adaptation and mitigation strategies, policy and technological innovation. This should be supported by investments to build the capacities of national research institutions to address nutrition security under a changing climate, and to mainstream nutrition security into climate resilient development and adaptation plans in Africa.

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Annex 1 - Key terms used

HUNGER AND UNDERNUTRITION

Malnutrition is a broad term that refers to all forms of poor nutrition. Malnutrition is caused by a complex array of factors including dietary inadequacy (deficiencies, excesses or imbalances in macronutrients –carbohydrates, protein, fats– and micronutrients), infections and socio-cultural factors. Malnutrition includes undernutrition as well as overweight and obesity (Shekar M, 2009; UNSCN, 2010; SUN, 2010).

Hunger is a term which literally describes a feeling of discomfort from not eating, and which has also been used to describe undernutrition, especially in reference to food insecurity (Black et al, 2008).

Undernutrition exists when insufficient food intake, repeated infections and poor care practices result in one or more of the following: underweight for age, short for age (stunted), thin for height (wasted), and functionally deficient in vitamins and/or minerals (micronutrient malnutrition) (based on UNSCN, 2010).

Stunting reflects shortness-for-age; an indicator of growth retardation and calculated by comparing the height-for-age of a child with a reference population of well-nourished and healthy children (SUN, 2010).

Wasting reflects a recent and severe process that has led to substantial weight loss, usually associated with food shortages, disease, inappropriate child-caring or feeding practices or a combination of such factors. Wasting is calculated by comparing weight-for-height of a child with a reference population of well-nourished and healthy children. Wasted children are very susceptible to infections and death. It is often used to assess the severity of emergencies because it is strongly related to mortality.

Food security exists when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life; household food security is the application of this concept to the family level, with individuals within households as the focus of concern (FAO, 2002; FAO, 2009; UNSCN, 2010).

Nutrition security exists when food security is coupled with a sanitary environment, adequate health services, and proper care and feeding practices to ensure a healthy life for all household members (Shekar M, 2009; UNSCN, 2010; SUN, 2010).

'Shocks' are defined here as 'sudden events such as floods, epidemics, droughts, but also wars, persecution and civil violence', and **'stresses'** are defined as 'pressures which are cumulative and continuous, such as seasonal shortages and climate variability, soil degradation, population pressure' (Chambers and Conway, 1991).

CLIMATE CHANGE

Climate change refers to any change in climate over time (decades or longer), whether due to natural processes or as a result of human activity. This definition is in line with the IPCC (the UNFCCC only considers the changes in climate only as a result of human activity).

Climate variability denotes deviations of climate statistics (mean state, standard deviations, the occurrence of extremes, etc.) over a given period of time, such as a specific month, season or year, compared to the long-term climate statistics relating to the corresponding calendar period. Examples of climate variability include the fluctuations that occur from year to year, the statistics of extreme conditions such as severe storms or unusually hot seasons, and conditions that result from periodic El Niño and La Niña events. As a result of climate change, climate variability is expected to increase in most locations.

Vulnerability is the degree to which people, communities and the systems on which they depend are susceptible to, and unable to cope and adapt when exposed to climate change. Resilience can be seen as the opposite of vulnerability.

Resilience is the degree to which people, communities and the systems on which they depend are persistent to, and able to adapt when exposed to climate change. **Adaptive capacity** is the capacity of people and communities – using available knowledge, skills, resources, information, technology, services and institutions – to cope with climate-related hazards and adapt to climate change, i.e. to anticipate and prepare for the hazard(s); to prevent or moderate the adverse effects of the hazard(s); to respond to and quickly recover from any adverse effect of the hazard(s); to adapt to stress and change and to take advantage of eventual opportunities, while maintaining or improving their situations and ways of functioning as compared to before the hazard(s) occurred.

Climate change adaptation refers to actions, measures and processes taken by people, communities and institutions which might ultimately reduce vulnerabilities, build resilience and enhance adaptive capacities to actual or expected changes in climate and their effects, within the broad context of sustainable development.

Climate change mitigation it refers to actions, measures and processes taken to reduce the sources of or enhance the sinks of greenhouse gases.

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