C-ADAPT

Climate Resilience for Food Security

How Climate Drives Hunger: Food Security Climate Analyses, Methodologies & Lessons 2010-2016

WFP World Food Programme

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Syrian beneficiaries in Iraq where WFP uses vouchers which can be redeemed for locally produced food, thereby boosting smallholders and the economy.

WHAT is this Analysis Compendium?

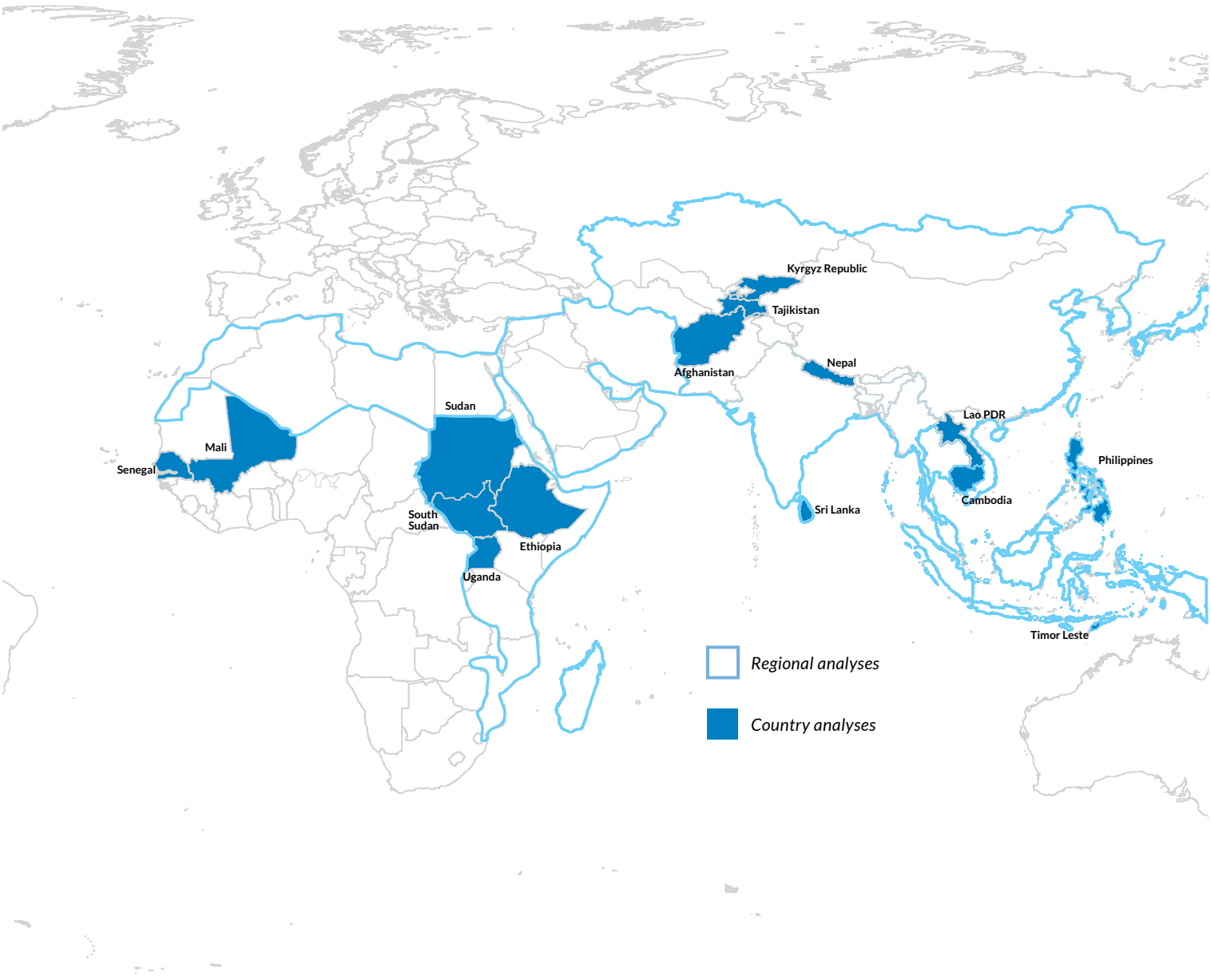
This document is part of the **Climate Adaptation and Resilience for Food Security:** *Analysis*, *Innovations* and *Standards* Series.It provides a compendium of the main findings and lessons learnt from food security climate analyses that have been undertaken by WFP and partners under the Climate Adaptation Management and Innovation Initiative (C-ADAPT).

WHO is this Compendium for?

This compendium is targeted at government policy makers, humanitarian partners, and technical analysts interested in accessing a snap shot of a range of food security climate analyses undertaken by the World Food Programme and partners.

An improved understanding of climate change on food security can inform decision-making and encourage investment within policies, plans and interventions undertaken by governments, development practitioners and communities. This knowledge sharing can also support the generation of new partnerships and build technical capacities in analytical methodologies and tools across a wide variety of contexts.

Food Security Climate Analyses, 2010-2016



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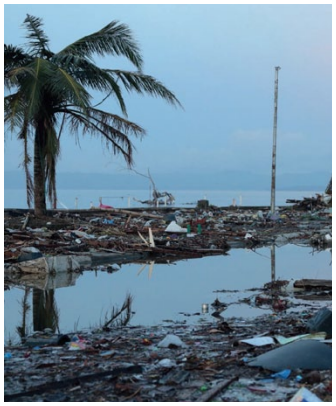


1. Introduction

The fifth assessment report of the Intergovernmental Panel on Climate Change (2014) highlighted that climate change will exacerbate existing threats to food security and livelihoods.

Climate change disproportionally affects the most vulnerable people, especially women and children. Climate-related hazards – particularly floods, storms and droughts – are becoming more frequent and intense, land and water more scarce and difficult to access, and increases in agricultural productivity even harder to achieve. It has been estimated that, unless considerable efforts are made to improve people's resilience, the risk of hunger and child malnutrition could increase by up to 20 per cent due to climate change by 2050.[1]

Currently limited research exists to help understand the impacts of climate change on food security. This is in particular when expanding to questions beyond the effects of climate change on food availability (such as agricultural production), to explore broader concerns on how people's food access, utilisation and stability over time will be impacted. Such questions require a stronger understanding of livelihood and food systems, trends in poverty and demographics, the dynamics of diets and nutrition, socio-economic and governance issues, among others.

The World Food Programme has been working with partners to explore these questions with the aim to contribute to the global effort to improve the evidence base of the impacts of climate change on all aspects of food security. A key component is to build on WFP's expertise in food security and vulnerability analysis mapping by developing tools and methodologies that will support countries in climate analysis efforts now and in the future. Importantly, these analyses should better inform and integrate evidence into policy and programme work. This includes supporting governments' national adaptation plans (NAPs), nationally determined contributions (NDCs) and other policies to help ensure food security is prioritised within climate change adaptation plans and interventions.

1. Perry et al (2009) *Climate Change and Hunger Responding to the Challenge.*

Snapshot of impacts of Typhoon Haiyan in the Philippines.

WFP has been undertaking this work under the Climate Adaptation Management and Innovation Initiative (C-ADAPT). Launched in 2013, C-ADAPT has been funded by the Swedish Government's fast-track climate finance as an innovative global initiative focused on integrating climate and food security analysis with programme and policy design. Support from the Government of Luxembourg, the Norwegian Ministry of Foreign Affairs, and the research programme on Climate Change, Agriculture and Food Security (CCAFS) of the Consultative Group on International Agricultural Research (CGIAR) have also contributed to making climate analyses under C-ADAPT possible.

C-ADAPT has focused on two main components: (i) climate analyses that serve to address the limited amount of research on the impacts of climate change on food security; and (ii) models and standards that can provide more examples and guidance to governments, communities and international organisations on climate change adaptation programmes that address food security concerns.

This synthesis captures the first component of C-ADAPT. The report acts as a compendium of the main findings from food security climate analyses undertaken by WFP and partners around the world, and documenting key lessons learnt from these efforts. A separate compendium of case studies, best practices and guidance on climate change adaptation for food security is being produced under the C-ADAPT Models and Standards component of the initiative. This sharing of knowledge is in line with the spirit of WFP's commitment under C-ADAPT to make such learning accessible to government policy makers, humanitarian partners, communities and other relevant stakeholders. Such knowledge sharing aims to support the building of capacities, to harness the generation of new partnerships, and allow for replication of analytical methodologies and tools in a wide variety of contexts. This in turn should allow for a better understanding of climate change on food security to be prioritised and incorporated into government policies, plans and interventions.

More than half of the world's population now lives in urban areas where the majority of population growth is occurring. Rapidly growing unplanned informal settlements could increase vulnerability to natural hazards.

Between 20 and 25 per cent of the territory of Bangladesh is inundated every year. In years with extreme flooding, up to 60 percent of the country is affected. Floods result in destruction of crops and agricultural land, loss of livelihood assets, and can increase incidence of undernourishment.

Types of food security climate analyses

To explore the impacts of climate risks and climate change on food security, it is useful to visit the definition of food security:

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[2]

Food security in this light involves four tiers of analysis: food availability, food access, food utilisation, and stability of all factors over time.

WFP has identified two key types of climate analyses for understanding the impacts of climate change on food security.

1. **Climate risk analyses in the food security context** aim to identify how climate variability will impact people's food security, livelihoods and nutrition. They identify past and current climate trends, identify geographic patterns of vulnerability, understand how previous climate shocks and stressors align with trends in food security outcomes and understand the extent to which different sources of food, income and expenditure are sensitive to climate variables, for different wealth groups in different livelihood zones.

2. **Climate change analyses** extend beyond looking at the impact of climate variability on specific variables today and in the recent past by using projections to try to estimate future impacts on those same variables. Through these projections, such analyses are useful to examine longer-term impacts of climate change, above and beyond climate risks.

These analyses can help guide adaptation planning and programme design for a wide range of stakeholders, including communities, government and international agencies by identifying priority areas that are particularly vulnerable to climate change. By highlighting how certain risks are likely to manifest, robust analysis can also help identify the most appropriate types of interventions needed. Such analyses are also important in providing hard evidence for where climate financing should be targeted.

A range of food security climate analyses have been undertaken by WFP and partners over the course of the C-ADAPT initiative, at the global, regional and country level. This compendium provides a summary of these findings for ease of access by policy makers, humanitarian actors and technical analysts. The full and detailed reports can be accessed by following the hyperlinks included in this compendium.

Active involvement of farmers is key to promote the transformative change required in light of the negative impacts of climate change on food security and nutrition. In the picture, sweet potatoes multiplication in Lokariwon, Uganda.

2. Food and Agriculture Organization (FAO) (1996) *Rome Declaration on World Food Security.*

2. Global analyses

WFP and partners have undertaken a number of global analyses in recent years, in order to better understand the worldwide impacts of climate change on hunger and food security. Such information has been particularly helpful in informing international policy makers, including technical inputs into global climate discussions, especially the United Nations Framework Convention on Climate Change (UNFCC), the Intergovernmental Panel on Climate Change (IPCC) and associated bodies.

Women in Shash Pul Valley, Bamyan, Afghanistan — Afghan women's employment rates varies significantly between urban, rural, and Kuchi (nomadic pastoral) populations, being significantly higher among Kuchi women (close to 50 percent) than rural women (about 30 percent) and urban women (about 20 percent).

The Food Insecurity and Climate Change Vulnerability Index and Interactive Map, 2015

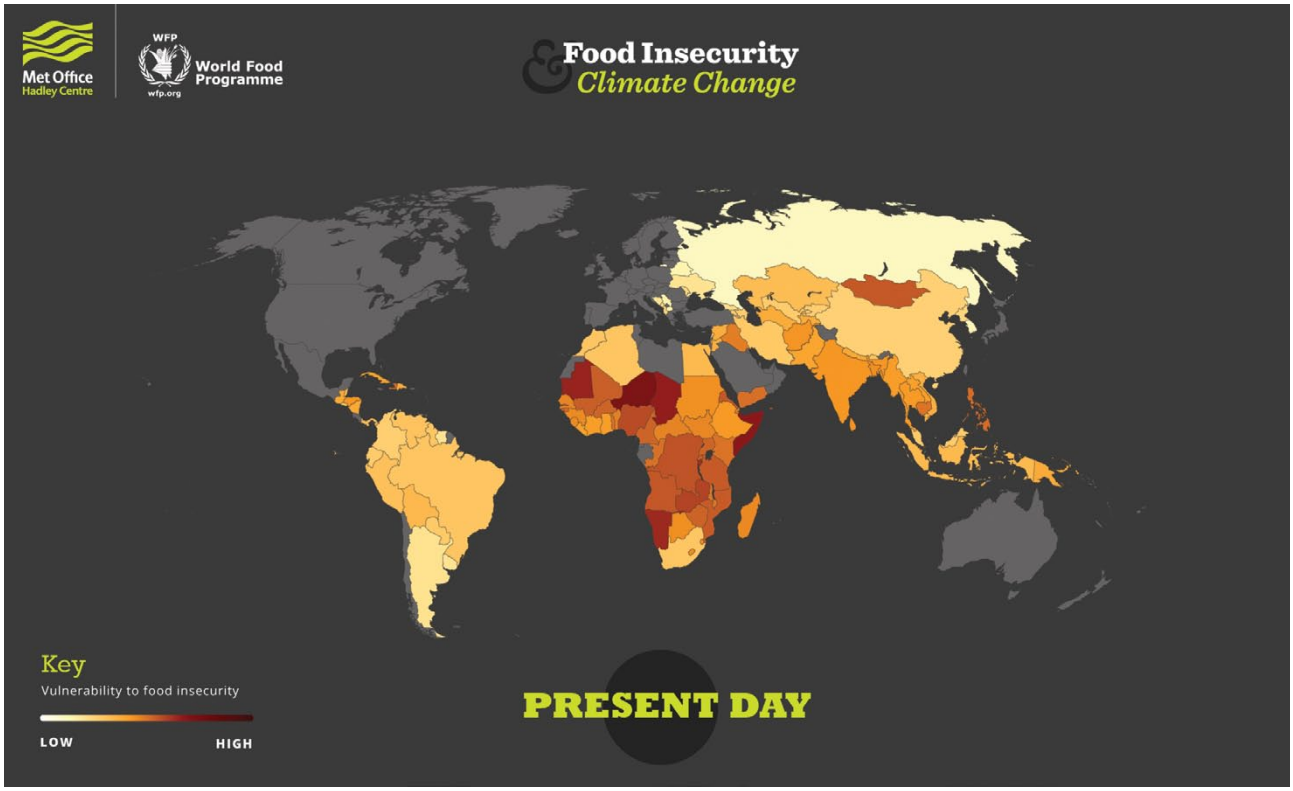
Partners: *WFP and Met Office Hadley Centre; with funding support from Sweden, Luxembourg and Norway*

WFP and the United Kingdom's Met Office Hadley Centre launched in 2015 at the Paris climate negotiations an interactive map based on a jointly developed Food Insecurity and Climate Change Vulnerability Index that offers a window in the global future of food security under a changing climate. The map highlights that depending on our actions, future generations will inherit a world with less vulnerability than today – or a world with significantly more vulnerability to food insecurity.

The index was developed to provide scientific information about current and potential countries' vulnerability to food insecurity at different global warming scenarios. Based on Krishnamurthy et al 2014, the index measures vulnerability to food insecurity which is defined by a composite index based on measures of exposure, sensitivity and adaptive capacity. Projections of future levels of vulnerability were made for year 2050 and 2080, considering three climate scenarios associated with low, medium and high greenhouse gas emissions and three options of no, low and high levels of investment in adaptation.

FIGURE 1A

The highest levels of vulnerability to food insecurity at present day are in Sub-Saharan Africa, with mediums levels across much of Asia and lower levels in South and Central America



Source: *WFP, UK Met Office.*

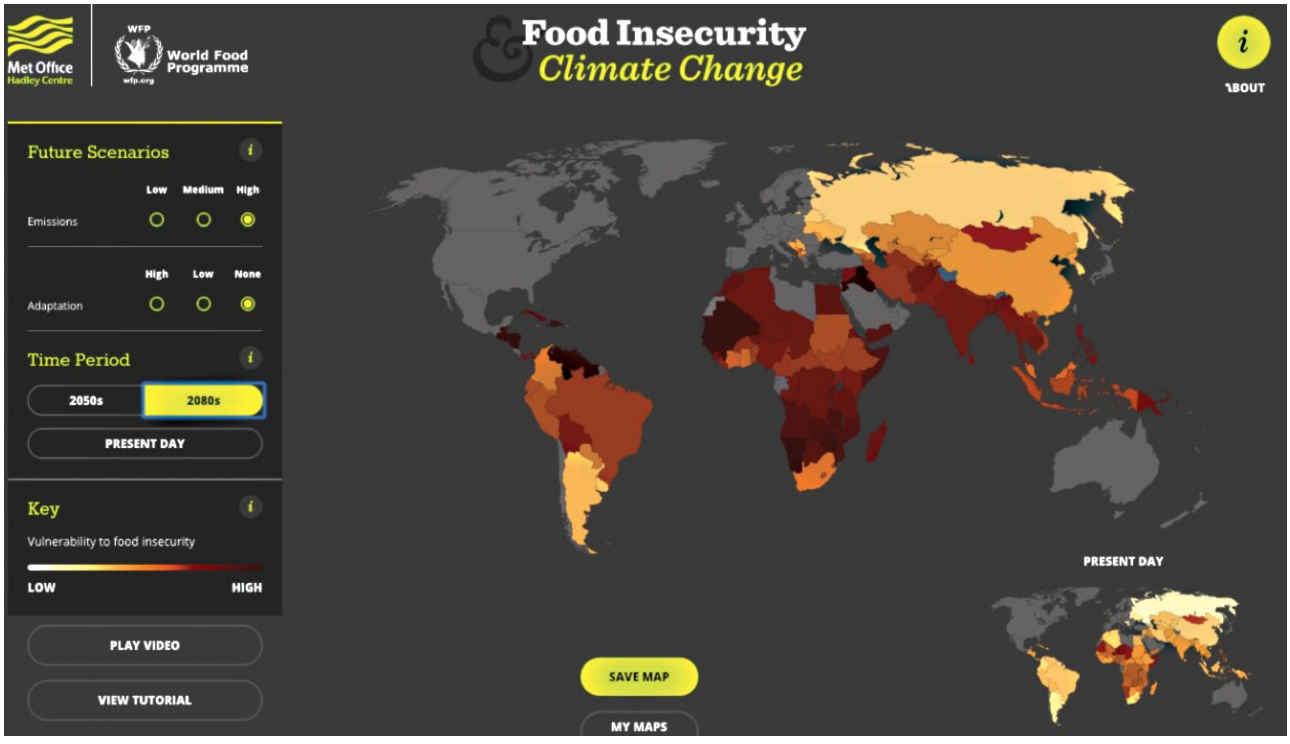
For further information please visit: http://www.metoffice.gov.uk/food-insecurity-index/.

The results indicate that today the highest levels of vulnerability to climate-related food insecurity are in sub-Saharan Africa, medium levels across much of Asia and lower levels in South and Central America. Projections indicate that regardless of the greenhouse gas emission levels, vulnerability to food insecurity will be increased by 2050 given the inertia of the climate system (i.e. a delayed response of warming), however this could be offset by investments in adaptation. In fact, if there is a rapid and sustained reduction in future emissions, then vulnerability to food insecurity remains steady after the 2050s to the 2080s; combined with adaptation, improvements can be made to the present day situation. However, if there are considerable future increases in emissions, then vulnerability to food insecurity from the 2050s will continue to increase. Although adaptation measures can limit this deterioration, the situation by the 2080s could still be worse than the present day.

The index highlights that to achieve the Sustainable Development Goal 2, major increases in investment are needed to end hunger by 2030 and to enable the poorest people to build resilient livelihoods. It also shows that even after 2030, because of climate change we will need to remain vigilant and continue to invest heavily in adaptation to preserve the gains we make in the next 15 years.

FIGURE 1B

An example of the Food Insecurity and Climate Change Vulnerability Index, where a future world in 2080 with high emissions and no adaptation shows a very food insecure world



Source: *WFP, UK Met Office.*

For further information please visit: http://www.metoffice.gov.uk/food-insecurity-index/.

Food Insecurity and Climate Change, 2010

Partners: *WFP and Met Office Hadley Centre; with funding support from Luxembourg*

The interactive map launched in 2015 builds off previous work that WFP and the United Kingdom's Met Office Hadley Centre had undertaken with its work on a Hunger and Climate Vulnerability Index, weaving together information on climate change and food security to show how the two are interlinked. A poster summarised the findings to support policy makers and the general public in understanding the impacts of climate change on people's hunger around the world.

A family in water-scarce Yemen receiving food assistance from WFP .

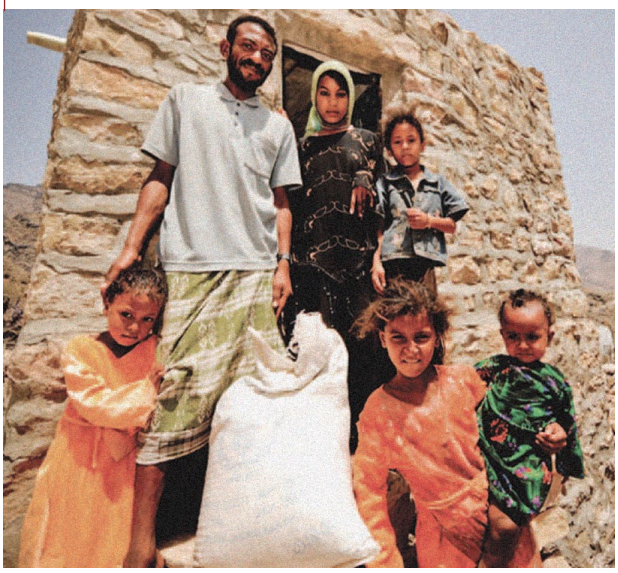
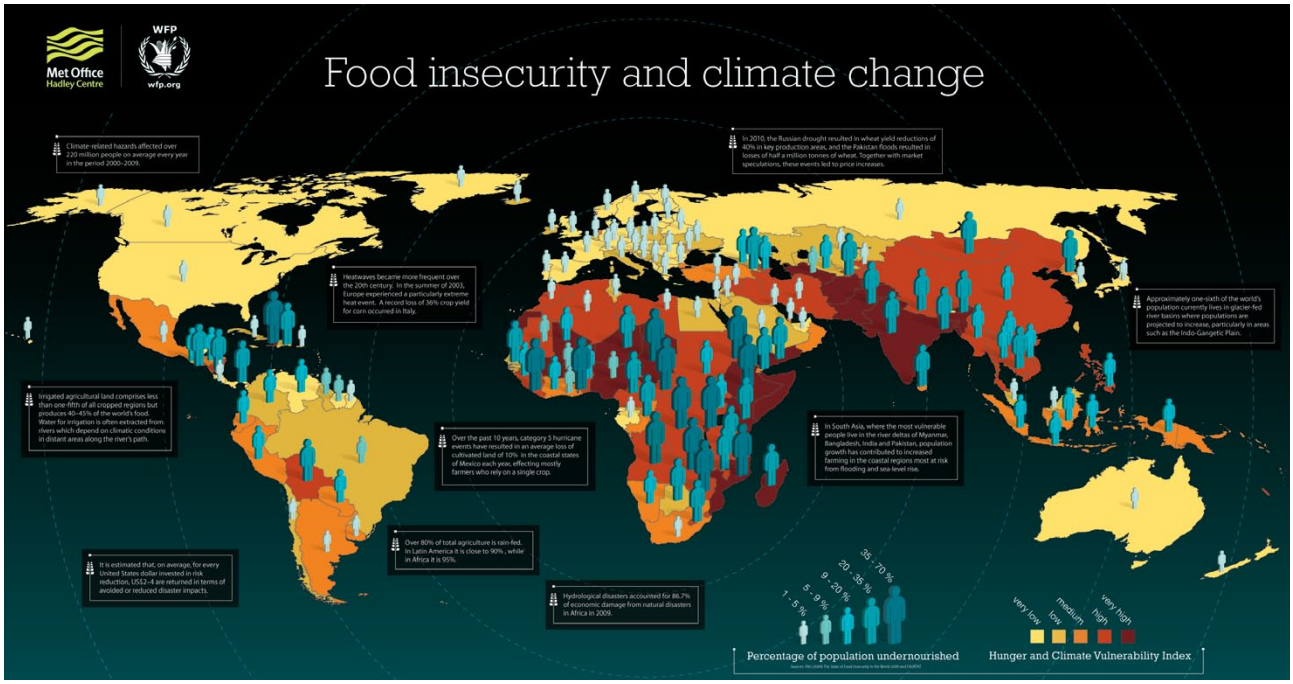


FIGURE 2

The Food Insecurity and Climate Change poster produced from the Hunger and Climate Vulnerability Index, 2010



Source: *WFP, UK Met Office.*

To view this map in more detail, please visit: http://www.wfp.org/content/maps-food-insecurity-and-climate-change.

Climate Impacts on Food Security and Nutrition: A Review of Existing Knowledge, 2012

Partners: *WFP and Met Office Hadley Centre*
Source: WFP, UK Met Office

Among the most significant impacts of climate change is the potential increase of food insecurity and malnutrition. This primer was developed jointly by the UK's Met Office and WFP to summarise the current state of knowledge on the impacts of climate change on food security and nutrition. It examines how climate change exacerbates the risks of hunger and undernutrition through two main mechanisms:

- **Extreme weather events.** The frequency and intensity of some disasters such as droughts, floods and storms could increase, with an adverse impact on livelihoods and food security. Climate-related disasters have the potential to destroy crops, critical infrastructure, and key community assets therefore deteriorating livelihoods and exacerbating poverty.

- **Long-term and gradual climate risks.** Sea-level will rise as a result of climate change, affecting livelihoods in coastal areas and river deltas. Accelerated glacial melt will also affect the quantity and reliability of water available. Under warming trends, glacial melt could accelerate, and the melt season would begin earlier in the year.[3]

3. More information about these type of risks is found at: UNFCCC (2012) Slow onset events: Technical paper. http://unfccc.int/resource/docs/2012/tp/07.pdf.

Integrated interventions in agriculture and market support are among WFP's priorities in Uganda and complement government initiatives to improve grain quality, increase production and enhance adaptation capacities of food insecure populations.
In the picture, Fatuma Nakieny, holding sweet oranges plants in tree nursery in Kalapata, Uganda.

Extreme weather effects disrupt the stability of food supply as well as people's livelihoods in Myanmar.

FIGURE 3

A summary of the consequences of the impacts of climate change on the different dimensions of food security

FOOD SECURITY DIMENSION	CONSEQUENCES OF CLIMATE CHANGE
AVAILABILITY *(sufficient quantity of food for consumption)*	• Reduced agricultural production in some areas locally (especially at tropical latitudes) could affect dietary diversity • Changes in the suitability of land for crop production • Changes in precipitation patterns could affect the sustainability of rain-fed agriculture in some areas • Increases in temperature could lead to longer growing seasons in temperate regions and reduced frost damage • CO_2 fertilisation could increase yields for those crops with the physiology to benefit from CO_2 enrichment
ACCESS *(ability to obtain food regularly through own production or purchase)*	• Lower yields in some areas could result in higher food prices • Loss of income due to the potential increase in damage to agricultural production
STABILITY *(risk of losing access to resources required to consume food)*	• Instability of food supplies due to an increase in extreme events • Instability of incomes from agriculture
UTILISATION *(quality and safety of food, including nutrition aspects)*	• Food security and health impacts include increased malnutrition • Ability to utilise food might decrease where changes in climate increase disease • Impact on food safety due to changes in pests and water pollution

3. Regional analyses

Three regions have been involved in the C-ADAPT initiative, as part of a decentralised effort to consider climate change under different contexts. This has helped to produce a richer understanding of the complexities and issues to consider when examining climate change and food security concerns, while also helping to better support governments and partners with better targeted analysis, policy and programming options. The three regions are: Asia; the Middle East, North Africa, and Central Asia; and East Africa.

Climate-related hazards – particularly floods, storms and droughts – are becoming more frequent and intense, land and water more scarce and increases in agricultural productivity even harder to achieve. In the picture, the relief food distribution at Hadew village in Jijiga district, Somali Region.

ASIA

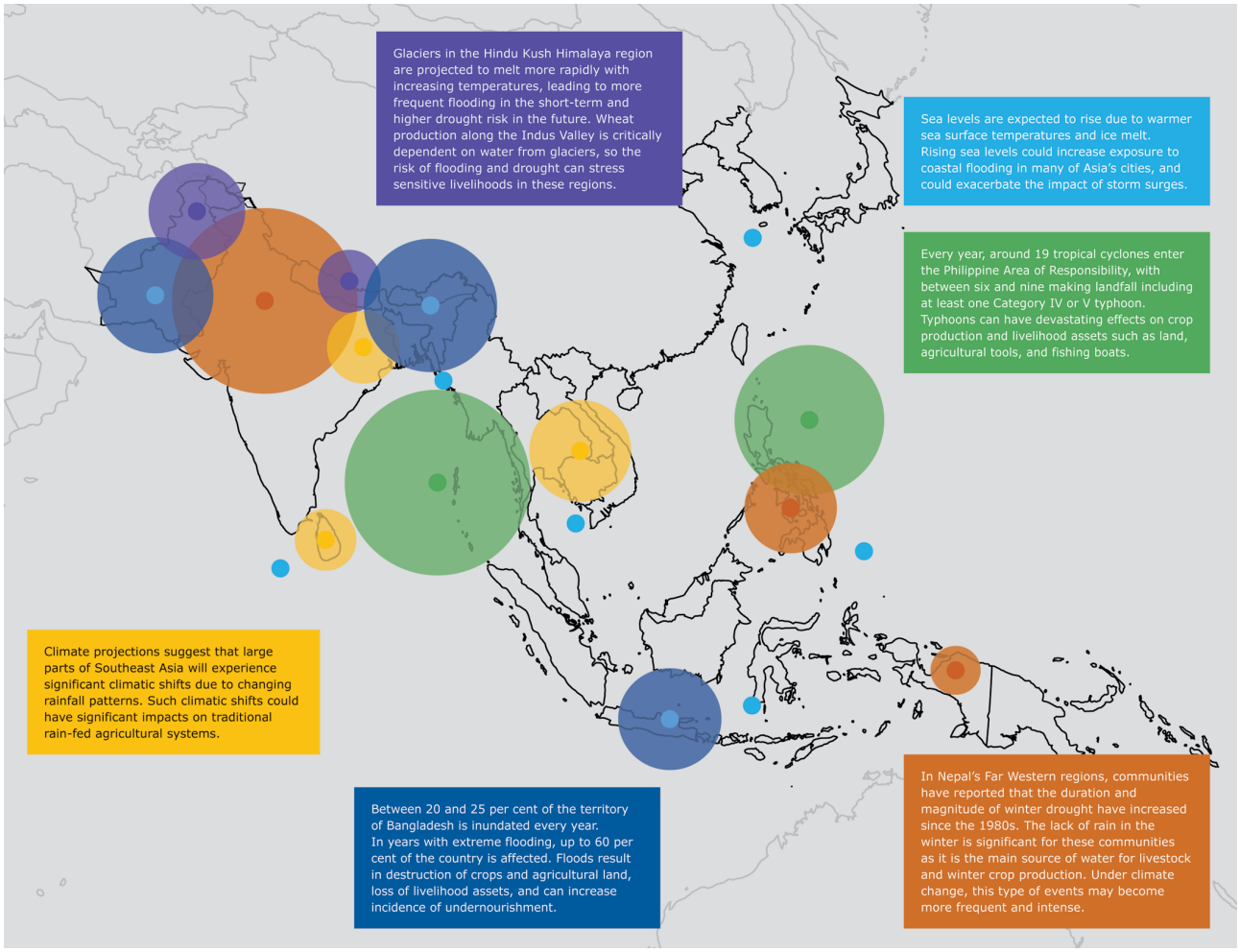
Climate impacts on food security and livelihoods in Asia - A review of existing knowledge, 2016

Partners: *WFP, Met Office Hadley Centre, International Water Management Institute (IWMI) and the CGIAR research programme on Climate Change, Agriculture and Food Security (CCAFS), with funding support from Sweden*

This review undertaken in Asia provides the current state of knowledge on the relationship between climate change and food security within the region. Results indicate that Asia is particularly vulnerable to climate change, due to a combination of: high reliance on climate-sensitive livelihoods, high incidence of poverty and food insecurity, and high population densities in vulnerable areas exposed to climate-related hazards such as floods, cyclones and droughts, and long-term climate change such as gradual changes in monsoon patterns, glacier melt and sea-level rise.

FIGURE 4

Summary of hunger risk resulting from the impacts of climate change on hunger in Asia



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Several studies indicate that climate variability could affect households' ability to access food through increases in food prices and negative impacts on the suitability on certain livelihood activities highly sensitive to changes in rainfall and temperature. Food utilization and therefore nutrition and health might also be affected through impacts on care practices and sanitation, with recent evidence suggesting that climate extremes and climate-induced crop and livestock failure are associated with negative outcomes on nutrition. Some studies have identified a correlation between higher temperatures and food poisoning, increased episodes of diarrhoea, acute respiratory infections, measles and meningitis. In addition, it is expected that food security concerns in urban areas will become more relevant in the future, in light of the prominent urbanization process in Asia.

Impacts of extreme weather events will be particularly relevant for the region. Between 2002 and 2011, droughts, floods and storms in the continent have resulted in losses of more than US $ 60 billion every year. In 2011 alone, climate-related disaster forced over 10 million people out of their homes in Asia. Sea level rise and glacier melt are also of increasing concern in the region in terms of water stress, soil salinity and impacts on livelihoods and human settlements.

Asia is extremely vulnerable to the impacts of extreme weather events. Between 2002 and 2011, droughts, floods and storms in the continent have resulted in losses of more than US $ 60 billion every year.

Loss & Damage in the Asian Context: Repairing shattered lives, 2014

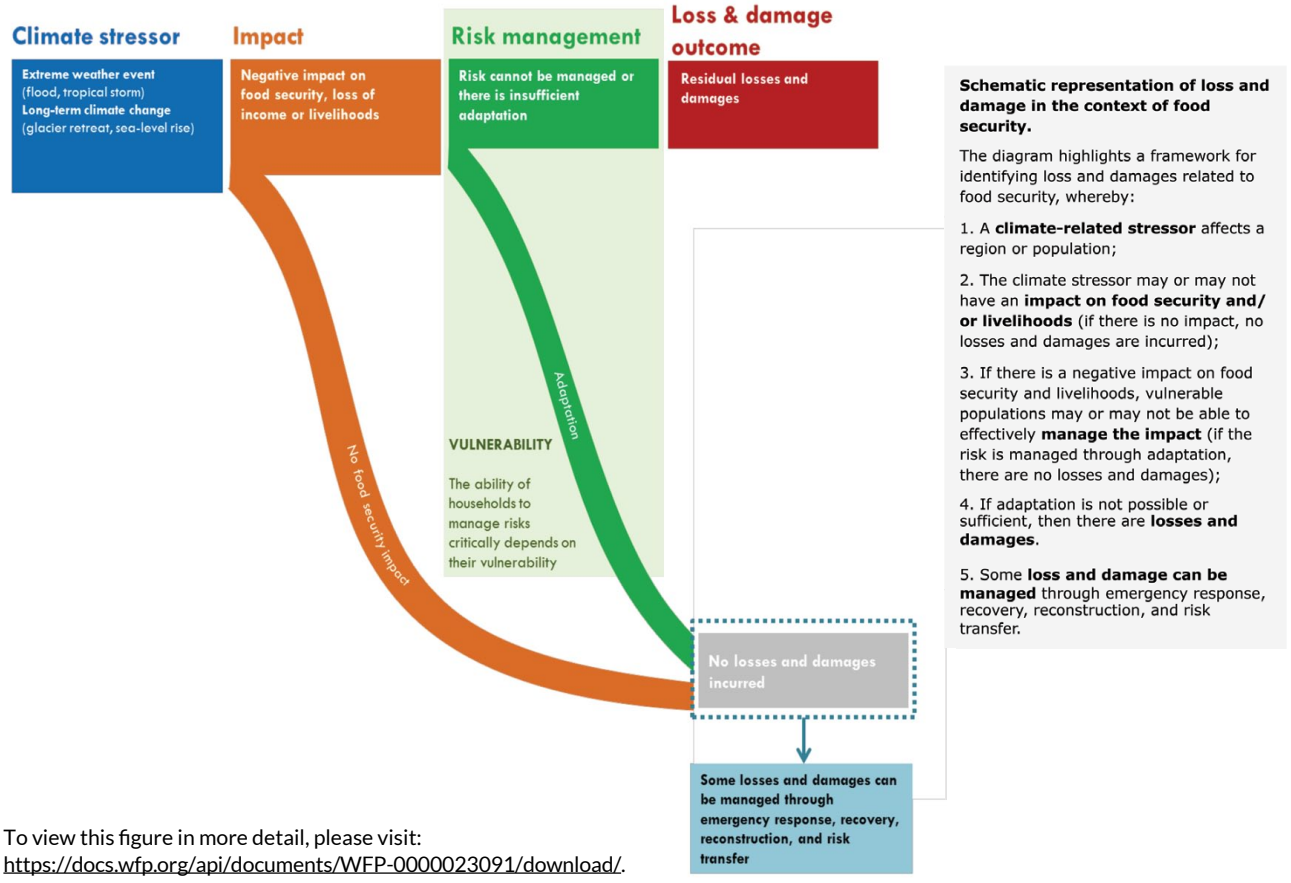
Partners: *WFP; with funding support from Sweden*

This paper examines how the United Nations Framework Convention on Climate Change initial two-year work programme on Loss & Damage (L&D) relates to food security and livelihoods, and proposes recommendations for managing loss and damage based on evidence from Asian countries.
One of the most quantifiable effects of residual L&D in the context of food security is the effect of climate change on agricultural production, such as crop losses as well as through longer-term impact on livelihoods. Climate risks may damage key natural resources such as land and water, as well as important assets. Where loss and damage has been severe, traditional livelihoods may no longer be possible.

The document also highlights the potential impacts on nutrition. Changing climate patterns could directly result in crop and livestock failure and therefore affect calorie consumption, diet quantity, and diet diversity. Climate-related shocks impact dietary diversity and reduce overall food consumption with overall long-term detrimental effects on stunting. Indirectly, climate change could exacerbate health problems through changing disease patterns, as well as inadequate care practices due to livelihood pressures on mothers.
For WFP, loss and damage resulting from climate change could mean additional humanitarian and food security challenges for the most vulnerable communities. Concretely, it could result in a wide range of impacts – ranging from land degradation, loss of assets, loss of key natural resources such as land and water, and loss of livelihood options, all of which can lead to destitution, displacement, and humanitarian crises.

FIGURE 5

Schematic representation of loss and damage in the context of food security



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THE MIDDLE EAST, NORTH AFRICA AND CENTRAL ASIA

Food in an Uncertain Future: The impacts of climate change on food security and nutrition in the Middle East and North Africa, 2015

Partners: *WFP and the Overseas Development Institute (ODI); with funding support from Sweden Food Security (CCAFS), with funding support from Sweden*

This report sets out to understand climate change risks to food security in the Middle East and North Africa (MENA) and how these vulnerabilities interact with other key trends and sources of risk, including population growth, urbanisation, and conflict. It highlights the impacts of climate change on people's ability to purchase the food and consequences for a safe and healthy diet, alongside particularly vulnerable groups to be aware of, and more immediate options for reducing climate risks to food security by the year 2030.

Findings indicate that by 2030, people's food security in the region will be affected by more frequent, longer, and more intense heat extremes and droughts as a result of higher temperatures, precipitation changes, and sea level rise. Widespread and severe droughts will be more common in the Mediterranean area while the Maghreb and the Levant are likely to become drier. Major concerns are related to the frequency and magnitude of extreme weather events, rising temperatures, salt water intrusion, water stress, land degradation, and impacts on food safety, nutrition, crop yields and human health. Projections indicate that climate change will delay progress in reducing the number of malnourished children in the region.

Climate variability has been identified as a critical factor in determining the livelihoods of many poor and vulnerable people in the MENA region. By 2030, farming activities of food producers, particularly in remote and marginal environments dependent on rainfed agriculture, will be impacted by climate change and extremes. Impacts on income, food price volatility, health, and disruption of food supply chains from weather extremes such as storms and floods are also expected. In addition, while most of the undernourished people across MENA live in rural areas where poverty is also concentrated, urban food insecurity is an increasing concern, given demographic trends.

While climate extremes and climate change will act as a risk multiplier for food insecurity in the MENA region, the report underlines that the main drivers of food insecurity up until 2030 will be population growth, urbanisation, and economic changes. Population growth will increase demands on supply chains, infrastructure, and public services. Rapid urbanisation will change patterns of what food people eat, and how and where they get it. Economic change will drive employment and income and people's ability to purchase food. For non-producers, food security is more closely linked to employment, developments in global markets, the national economy, and how well governments and food systems respond to shocks such as global food price volatility. Poor consumers in rapidly growing urban areas are likely to be most vulnerable due to income insecurity and poor access to safety nets and basic services.

Worsening environmental conditions in Yemen combined with conflict have displaced millions of people.

FIGURE 6

Typical climate vulnerabilities of rural livelihood groups in the Middle East and North Africa

	Exposure	Sensitivity	Adaptive capacity
Pastoralists & Dryland farmers	- Heat extremes and temperature increases - Aridity and drought	- Highly sensitive to drought - Sensitive to land degradation - Livestock pests and disease	- Poverty extensive among small producers - Poor access to markets and services - Little off-farm income
Highland farmers	- Heat extremes and temperature increases - Aridity and drought - Changes in water availability due to snow melt	- Highly sensitive to drought - Sensitive to degradation of natural resources - Changes in viable crops	- Poverty extensive - Poor access to infrastructure, markets and services - Little off-farm income
Semi-arid farmers	- Heat extremes and temperature increases - Aridity and drought - Salt water intrusion - Changes in patterns of precipitation and water availability	- Highly sensitive to drought and aridity - Lower drought sensitivity amongst irrigation adopters, but increasing in future	- Moderate poverty among small producers - Better connections to markets and services - Off-farm income more significant
Irrigated areas	- Heat extremes and temperature increases - Upstream hydrological changes - Changes in water availability	- Lower drought sensitivity, but may increase in future - Moderately sensitive to temperature increases - Reduced sensitivity is dependent on maintenance of irrigation networks and water supplies	- Moderate poverty - Good access to markets and services - Off-farm income significant

The report also outlines key areas where measures can be taken to support adaptation and resilience of food systems. Adapting to climate shocks and stresses on food security will require investment, mainstreaming climate risk management and strengthening resilience throughout the food system. This will include adaptation of food production, improving water and energy security, macroeconomic management and reform of food subsidy systems, and reducing risks in food processing, storage, distribution, retail and consumption. Food security of households is interdependent with many other domains, ranging from income and employment to access to basic services and markets. Strengthening food security and reducing climate risks therefore requires integration and coordination across sectors.

EAST AFRICA

The Atlas of Climate Risk and Food Security in the Greater Horn of Africa Region, 2016

Partners: *WFP and the Intergovernmental Authority on Development (IGAD) Climate Prediction and Applications (ICPAC) and Disaster Management; with funding support from Sweden*

The Atlas of Climate Risk and Food Security in the Greater Horn of Africa has been produced by a number of stakeholders with an interest in understanding the impacts of climate variability on people's livelihoods and food security in the region. It maps past climate trends to identify geographic patterns of vulnerability, including climate shocks and stressors aligned to changes in food security. The Atlas underscores the extent to which different livelihoods are sensitive to climate variables at regional, national and local levels. Countries covered in the analysis include Burundi, Djibouti, Eritrea, Ethiopia, Kenya, Rwanda, Somalia, South Sudan, Sudan, Tanzania and Uganda.

The Atlas identifies a number of severe weather and extreme climate related shocks that cause food insecurity vulnerabilities to food insecurity, including: flash floods and extreme rainfall events; drought; cyclones; cold events; wind, dust, hail and thunder storms. Droughts and flood years frequently occur sequentially, exacerbating the impacts of extreme events on the regional economy. In addition, droughts occurring in areas exposed to land degradation increase the number of livelihoods' vulnerability to food insecurity. Other factors that aggravate vulnerability are also highlighted including: high population growth and density; unstable and increasing commodity prices that affect market accessibility; livestock and crop diseases and pests; and inadequate water resources for livestock production.

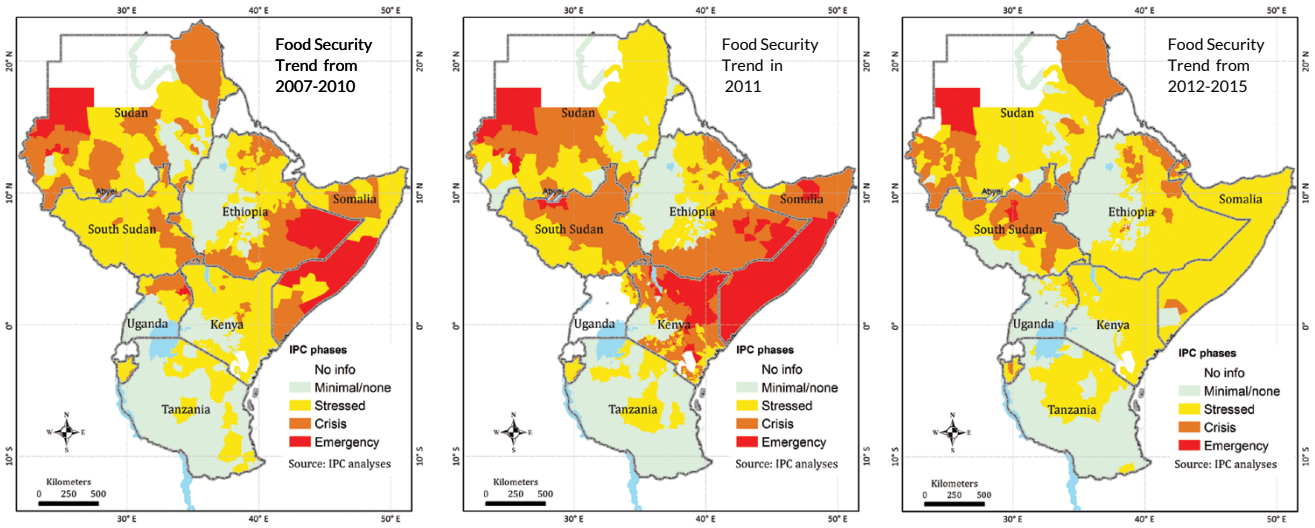
The study also examines El Niño events as a window into how extreme weather can impact food security. Such an analysis shows that composite seasonal rainfall during strong El Niño years lead to below normal rainfall seasons in the region's north and is associated with poor agricultural seasons and food insecurity. Meanwhile, the southern areas register above normal rains leading to flooding. During La Niña years, the impacts are reversed. These extreme oscillating climatic events highlight that climate risk is one of the key drivers of food insecurity in the Horn and Central Africa.

Despite the progress registered in the region after the 2011 food security crisis, food insecurity has remained more pronounced in countries affected by armed conflicts such as the Darfur region of Sudan and South Sudan, or those areas impacted by frequent poor rainfall such as parts of north eastern Ethiopia, Djibouti and Karamoja in Uganda. The rest of the region (Kenya, Burundi, Ethiopia, Somalia and central Tanzania) depict stressed conditions, affecting people's ability to afford food and making some essential non-food expenditures unattainable without negative coping strategies. Improved average food security in areas after 2011 can be attributed to early response mechanisms and countries being able to mitigate the impacts of the shocks. The most food insecure populations after 2012 are found in Sudan, followed by Ethiopia and South Sudan.

Climate shocks occurring in areas exposed to land degradation increase the number of livelihoods' vulnerability to food insecurity.

FIGURE 7

Sensitivity of East African countries to climate shocks, 2007 to 2015

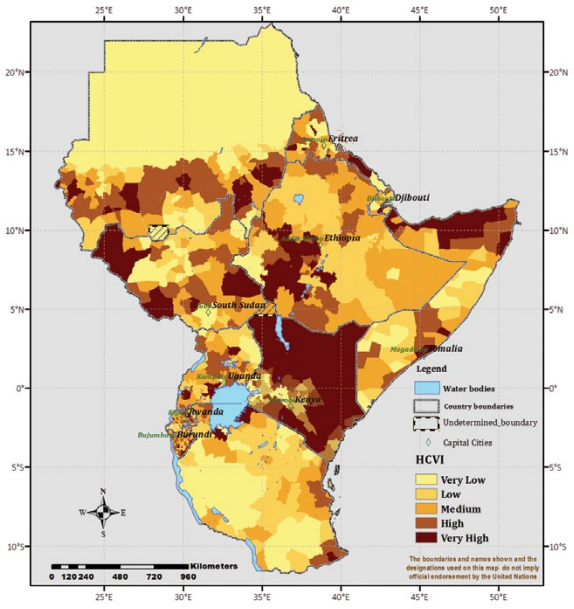


Source: *Integrated Food Security Phase Classification (IPC) country data, synthesised by WFP.*

The Atlas also applied the Hunger and Climate Vulnerability Index as a tool to understand climatic risks and vulnerability to food security at the district level within the East Africa region. The analysis examines vulnerability to climate change based on the relationship between the degree of climate stress on populations (exposure), the degree of responsiveness to stress (sensitivity) and the ability of populations to adjust to the climatic changes (adaptive capacity). The composite index incorporates socioeconomic and environmental indicators that are highly correlated and most relevant to food insecurity. The Index shows that most of Kenya is highly sensitive to climate variability, as well as Puntland and Somaliland of Somalia, western Ethiopia and most areas of Sudan and South Sudan.

FIGURE 8

Hunger and Climate Vulnerability Index for the Horn and Central Africa



4. Country analyses

Detailed climate analyses have been undertaken across a number of countries within which WFP operates, and which aim to support governments, humanitarian and other partners understand the impacts of climate change on people's food security so as to better support national policy and programme prioritization. These analyses are presented below.

A boy in Khram wa Sarbagh, Wakhan, Afghanistan—with future climate change, spring rainfall is expected to decrease over most of the country, except in the Wakhan corridor and small areas along the southern border. This is of particular concern given the importance of spring rainfall for plant growth, and suggests that agricultural droughts are likely to increase.

AFGHANISTAN

Climate Change in Afghanistan: What does it mean for Rural Livelihoods and Food Security? 2016

Partners: *WFP, National Environmental Protection Agency, United Nations Environment Programme; with funding support from Sweden*

This analysis in Afghanistan used the Consolidated Livelihood Exercise for Analysing Resilience (CLEAR) methodology and FEWSNet's Livelihood Zones (2011) to understand the impacts that climate change may pose for the country, even within the context of other priorities and challenges Afghanistan is facing.

The analysis recognises that climate change will make it very challenging for the country to maintain - let alone increase - economic and development gains achieved so far in Afghanistan. Increasingly frequent and severe droughts and floods, accelerated desertification, and decreasing water flows in the country's glacier-dependent rivers will all directly affect rural livelihoods, and therefore the national economy and the country's ability to feed itself. Agriculture is integral to Afghanistan's economy and food security, accounting as a source of income for 61 percent of the country's 29 million people and 44 percent of employment. Declining agricultural productivity could thus increase both the number of food insecure people, and the severity of existing food insecurity and malnutrition.

This analysis looks at how droughts and flood risks have changed over the past thirty years, and what impact this has had on rural livelihoods and food security in the country. The guiding question for the analysis was not "where have droughts or floods become more frequent and severe?", but rather "where has the impact of droughts and floods on livelihoods - and ultimately food security - increased most?"

The analysis focuses on the four climate hazards which pose the largest risk to livelihoods in Afghanistan. Results suggest that:

- While the risk of **rainfall-related drought** has increased over the past 30 years across most of the country, the main areas of concern for livelihoods and food security are in the north and parts of the Central Highlands. These are areas where the dominant livelihoods - rainfed farming and pastoralism - are highly dependent on rainfall, and where the observed decline in spring rainfall has a direct impact on households' ability to produce food and incomes.

- The negative impacts of **snowmelt-related drought**, caused by reduced winter snowfall in parts of the Hindu Kush mountains, seem to be much more concentrated, primarily in Kabul and surrounding regions. These densely populated areas, which produce much of the country's vegetables, fruits and cereals, are heavily dependent on irrigation from the Kabul river and its tributaries, which are fed in part by snowmelt from the Hindu Kush.

- The impacts of **floods caused by excessive rainfall** have been felt across a range of different livelihood zones, ranging from the mountainous areas in the north-east and centre of the country, to the hilly border areas in the south east, all the way down to the flat, arid southern provinces.

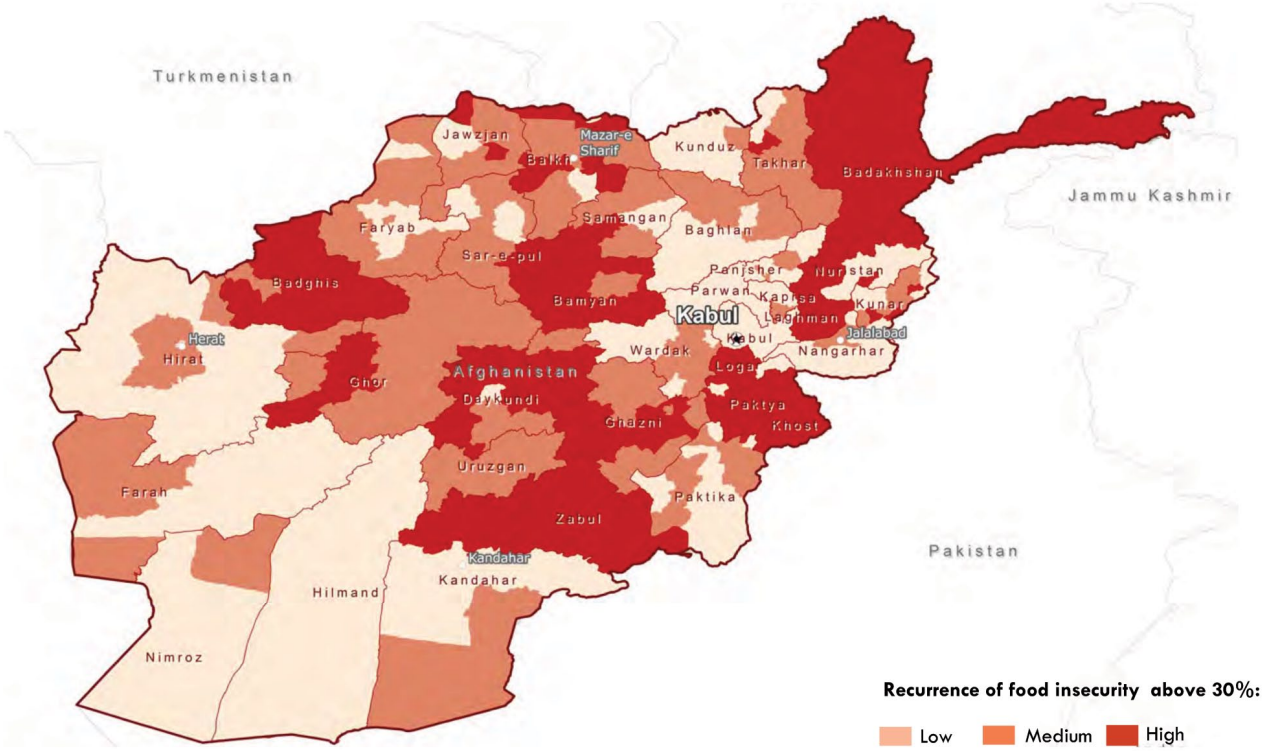
- Negative impacts of **increased snowmelt-related floods** seem to be concentrated along rivers in the eastern part of the Helmand river basin, where increased risk of snowmelt flooding overlaps with high livelihood vulnerability to flooding.

Climate projections suggest that the main negative impact of climate change in Afghanistan in the future will be increased drought risk—with increased flood risk being of secondary concern. Annual droughts in many parts of the country will likely become the norm by 2030, rather than being a temporary or cyclical event. This will mostly be due to higher temperatures leading to higher evapotranspiration and higher crop and livestock water demand.

Livelihoods in Afghanistan are heavily based on farming and livestock and are a source of income for over 60 percent of all households. As conventional crops become less and less viable in some areas of Afghanistan due to drought and desertification, rural populations required alternative livelihood options.

FIGURE 9

Food security trends in Afghanistan, 2007—2014



Source: *NRVA 2007/08, NRVA 2011/12, ALCS 2014.*

CAMBODIA

Consolidated Livelihood Exercise for Analysing Resilience (CLEAR) in Cambodia, 2014

Partners: *WFP and Mekong Adaptation and Resilience to Climate Change Project (Mekong ARCC); with funding support from Sweden*

This analysis identifies how different livelihood groups in Cambodia are vulnerable to climate trends and future climate change. As the north-eastern parts of the country are expected to experience some of the largest shifts in both temperature and rainfall, this would render rainfed agriculture unfeasible under future climate scenarios. Already today, communities have perceived major shifts in the seasonality of rainfall which is affecting rural livelihoods.

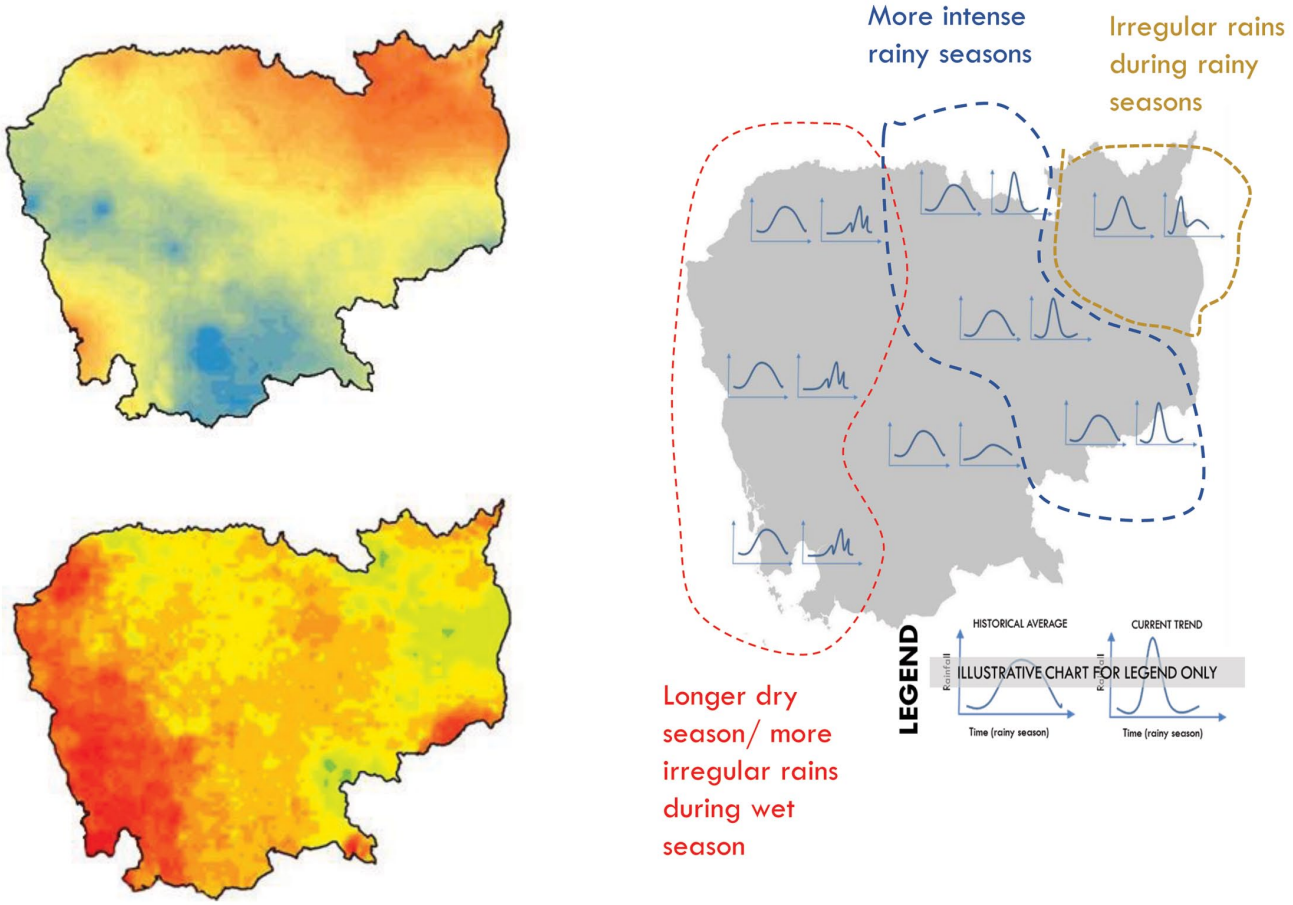
In the north-eastern parts of the country, the analysis has found that intense rainy seasons and irregular rainfall patterns are resulting in increased flood risks, which can result in waterlogging of cassava and corn. In the south-western parts of the country, by contrast, communities report longer dry seasons associated with a delay in the start of the rainy season. These perceptions are validated by an analysis of rainfall climatology and seasonality.

In addition, regional analyses show that the combination of increases in temperatures and shifts in rainfall patterns will result in lower suitability of rubber, cassava, and other industrial crops, providing an additional challenge to the feasibility of some livelihoods. The increasing reliance on these crops at both smaller and larger scales highlights the economic vulnerability of certain livelihood groups to major climate shocks. Shifts in rainfall may also result in higher drought risk, primarily affecting livelihood groups in the north-eastern parts of Cambodia where people are heavily dependent on reliable rainfall for their agricultural production. These findings have important implications for the choice of agricultural and livelihood interventions that will have a sustainable impact in the long-term.

In the north-eastern parts of Cambodia, where communities are heavily dependent on reliable rainfall for their agricultural production, shifts in both temperature and rainfall are expected to render rainfed agriculture unfeasible.

FIGURE 10

Changes in onset of rainy season and in uniformity of rainfall in Cambodia



Source: *Base layers provided by WFP's Food Security Analysis Service, Rome (OSZAF).*

Based on the projections from this study and further findings from field visits conducted in June 2014, Chey Commune in Kampong Thom was selected as the site for a pilot programme to enhance the resilience of vulnerable households to the impact of climate change. Follow up field work was conducted in October 2014 to determine the specific project objectives and activities. The project aims to improve the food security of vulnerable households by enhancing their resilience to the impacts of climate change. Its focus is on adapting farming systems to climate change, in order to reduce people's vulnerability to shocks and to improve their livelihoods. Three priority areas of intervention include: diversification of livelihoods towards less drought-sensitive activities; training for drought-resistant rice cropping techniques; and water resource management.

ETHIOPIA

Climate risk and food security in Ethiopia: Analysis of climate impacts on food security and livelihoods, 2014

Partners: *WFP and the CGIAR research programme on Climate Change, Agriculture and Food Security (CCAFS); with funding support from Sweden and Luxembourg*

Food security is highly sensitive to climate risks in Ethiopia. Historical and more recent climate-related events such as the 2008-2009 and 2011 food security crises in the Horn of Africa have highlighted the impact of droughts and floods on food production, access to markets, and income from agricultural activities.

Access to markets is critical for food security in Ethiopia. Even in the most productive areas, poorer farmers purchase some of their food, especially in pastoral and agricultural areas where rainfall has become increasingly erratic.

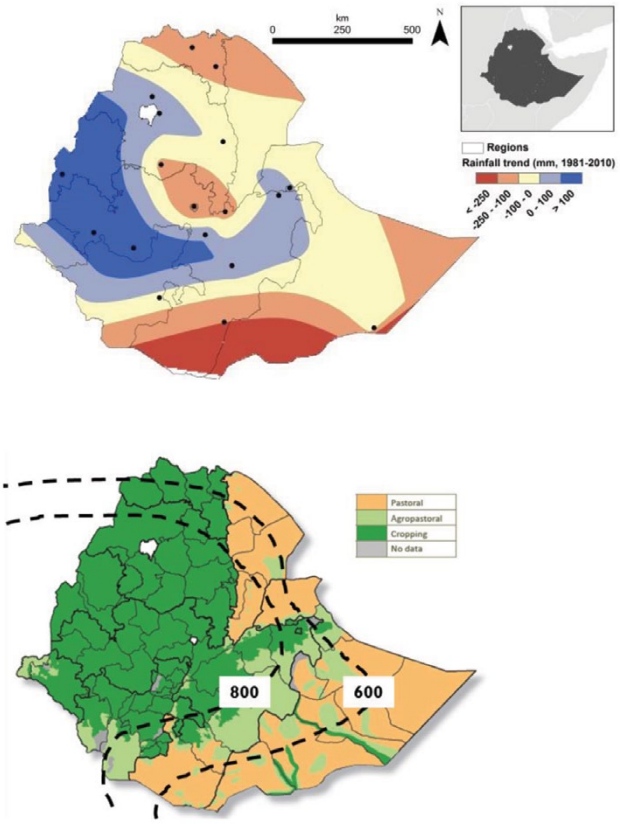
Ethiopia has a predominantly rainfed agricultural system, meaning rainfall is one of the main climatic determinants of food production in the country. Since 1980, annual rainfalls have declined within the March to September period. These declines have been most marked in belg[4]-dependent areas leading to more intense and frequent droughts. In addition, there has been a shift in the timing of rainfall, leading to more erratic and unpredictable precipitation patterns. Impacts on livelihoods are seen among the poorest farmers, who turn to negative coping strategies such as reducing the quantity or quality of meals, livestock sales (often selling their last productive female), or temporary labour migration.

This analysis highlights that critical intervention strategies should focus on livelihood and income diversification to ensure resilience against more intense climate-related risks. For example, migration (both seasonal and permanent) has become an important source of household income for at-risk populations. In addition, landscape transformation through land rehabilitation can also be a cost-effective solution to manage climate risks, by contributing to both drought and flood risk management. Both droughts and floods can occur in the same growing season, with potentially devastating impacts on crop and livestock production. Strategies to address climate risk should focus on developing capacities to better analyse and anticipate risks. The introduction of early warning systems and contingency plans can support climate risk management and food security strategies.

4. There are three seasons in Ethiopia. From September to February is the long dry season known as the bega, which is followed by a short rainy season, called the belg, in March and April. May is a hot and dry month preceding the long rainy season (kremt) in June, July, and August.

FIGURE 11

Distribution of key livelihood systems in Ethiopia overlaid with rainfall climatology, 1981 to present



Source: *USAID and DRMFSS, 2010, and NMA/IRI, 2012.*

KYRGYZ REPUBLIC

Climate Risk and Food Security Analysis: An overview of climate trends and the impact on food security Kyrgyz Republic, 2014

Partners: *WFP, the State Agency on the Environmental Protection and Forestry, the Climate Change Center of the Kyrgyz Republic, the National Agency for Hydrometeorology, and Tian Shan Policy Center of the American University of Central Asia; with funding support from Sweden and Luxembourg*

This analysis examined the historical relationship between climate, food security and the sensitivities of different livelihoods in the Kyrgyz Republic. The findings highlight that agriculture in the Kyrgyz Republic is sensitive to climate conditions, which could have a detrimental impact on the livelihoods of smallholder producers and subsequently retail prices in local markets, making food access unaffordable among the poor.

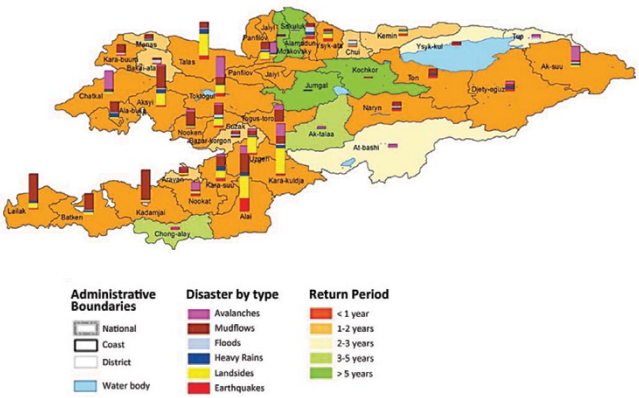
Increases in wheat flour prices, for example, would have a disproportionate impact on the already food-insecure market-dependent households who spend a larger proportion of their budget on purchasing wheat flour, such as those engaged in small-scale agriculture, unskilled wage labour and recipients of social allowances. These same groups show higher rates of food insecurity due to economic factors, and demonstrate more severe coping strategies in times of crisis. These groups also have a higher dependence on producing their own potatoes and vegetables, further exposing them to risks under adverse climatic conditions.

Geographically, low-lying parts of the country show trends of gradually become arid, affecting vulnerable livelihoods such as subsistence farmers. Extreme climatic events may also worsen. Long-term changes in seasonal patterns could also have a detrimental impact on food security – particularly in the southern parts of the country – and are apparent in the high variability between years and seasons across the country, especially between 1982 and 2011. The largest decreases in precipitation trends have been between the months of June and August in north-eastern parts of the country, while increases in rainfall have occurred between April and June, especially in the south. Models suggest increasing temperatures could exacerbate glacial melt and reduce snow cover that are critical to ensuring the availability of water for agriculture.

The outcomes of this study have highlighted three key areas for intervention. Firstly, the priority is to focus on those most vulnerable to food insecurity, by supporting livelihoods and income diversification of households that are dependent on small-scale agriculture, unskilled wage labour and social allowances. Secondly, there is a need to manage uncertainties associated with climate change by focusing on developing capacities to better analyse and anticipate risks with early warning systems, profiling of climate risks at sub-national levels, and developing contingency plans to support climate risk management. Finally, integrating and mainstreaming climate risk management into social protection and food security strategies is important, including for example, disseminating technologies, knowledge, skills and information for adaptation.

FIGURE 12

Expected trends of climate related hazards in Kyrgyz Republic



Source: *Ministry of Emergency Situation of the Kyrgyz Republic. Map produced by WFP.*

LAO PDR

Consolidated Livelihood Exercise for Analysing Resilience, 2016

Partners: *WFP, Ministry of Natural Resources and Environment's Department for Disaster Management and Climate Change (DDMCC) and the USAID Mekong Adaptation and Resilience to Climate Change Project (Mekong ARCC); with financial support from Sweden*

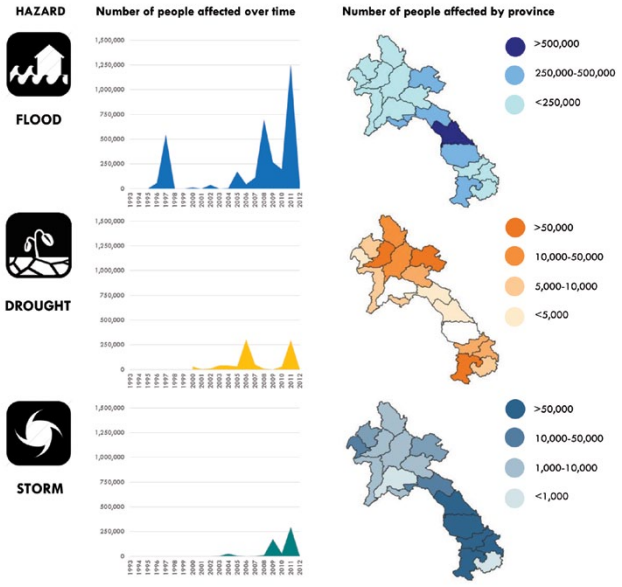
A Consolidated Livelihood Exercise for Analysing Resilience (CLEAR) approach was used in the Lao People's Democratic Republic, helping to examine both climate impacts on livelihoods, and to identify adaptation options for the most vulnerable livelihoods. The study analysed climate projections and potential impacts on livelihoods. In general terms, climate models show that Lao PDR will experience some of the largest changes in temperature and rainfall in the Lower Mekong Basin, including large increases in rainfall, more frequent large rainfall events, concentrated rainfall distribution, increases in tropical storm intensity, seasonal variability and increases in maximum temperature. It is expected that those changes will affect the suitability of key crops particularly rainfed rice, coffee, maize and cassava.

The analysis' main findings indicate that livelihoods dependent on highland paddy are among the least resilient – in part due to the rugged terrain and remoteness which limits access to land and additional livelihood activities. Communities dependent on highland paddy are also among the most severely affected by climate-related risks. The livelihoods with greatest climate resilience are those with sufficient access to financial capital (and wealth) and land, those which are highly diversified, and those which do not rely on rainfed agriculture. Focusing on activities linked to these characteristics will enhance community resilience.

The report also indicates that rural livelihoods, which provide an income to over two thirds of the population, continue to be highly climate-sensitive and are predominantly dependent on paddy-accounting for over 80 percent of all agricultural production. This situation has been identified as detrimental since the continued reliance on a single crop does not contribute to enhance resilience of vulnerable groups, making these people less prepared to address the effect of climate and non-climate shocks. Adaptation measures should focus on improving resilience to climate variability and extremes, including large increases in rainfall that increase flood risks, waterlogging of soils, and the incidence of fungal diseases for crops. Such measures should also take into consideration the potential increase in maximum temperature of approximately 2 to 3 degrees Celsius, which would exacerbate drought risk and severely impact crops and livestock.

FIGURE 13

Climate extremes affecting Lao PDR



Source: *Des Inventar Lao PDR (2015) | http://www.desinventar.net/DesInventar/.*

The study points out the need of promoting the diversification of livelihood as a key strategy for enhancing resilience, because households with diverse livelihood profiles are more capable of responding to shocks in case the primary activity is affected by a significant shock. Diversification away from paddy production is especially significant as it allows households to increase diet diversity (for example, higher consumption of animal products) as well as the number of income sources.

MALI

Climate and livelihood sensitivities in Mali, 2011

Partners: *WFP, International Research Institute for Climate and Society (IRI) of Columbia University*

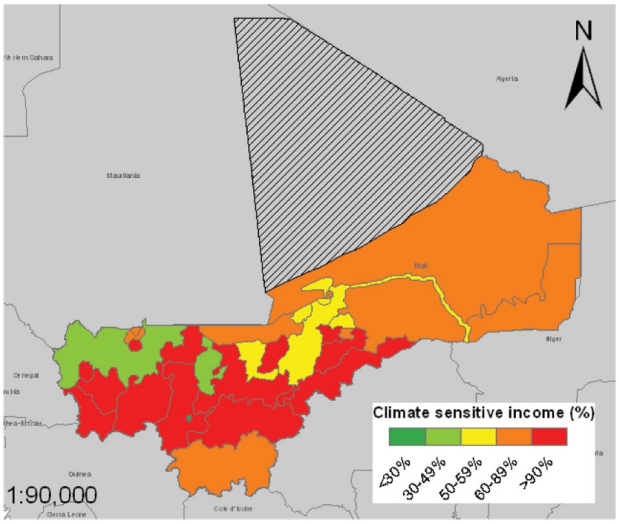
This analysis highlights that households in the semi-arid Sahelian centre are the most vulnerable to climatic risks in Mali. These households are typically the most food insecure, practicing agriculture as the main livelihood activity and with the least diversification of crops; they also consume a smaller proportion of food from their own production, and resort to negative food-based coping strategies during difficult times. Any alternate livelihood activities are usually directly dependent on rainfall, with precipitation variability resulting in lowering production of key crops, agricultural labour and economic output in poor households. Without any adaptation efforts targeted at diversifying livelihoods and ensuring their food access, it has been assessed that changes in rainfall could significantly exacerbate food insecurity in this region, particularly for those households that are just marginally food secure.

A more detailed examination of three regional areas in Mali highlight how livelihoods and food security will be affected by climate risks. First, in the desert north, pastoralism is the dominant livelihood activity, with long-term drought having already eroded traditional livelihoods. Second, in the Sahelian centre, most of the poor households purchase their food and communities, making them susceptible to food and other commodity price hikes. Thirdly, the recurrence of below-normal rainfall in the south can also affect water-intensive crops, giving rise to food insecurity as households are unable to sell their crops and lose purchasing power.

There are significant uncertainties in climate change projections due to the complexity of atmosphere-ocean-land interactions and computational limitations which do not capture processes at high spatial resolution. Despite the uncertainties, it is possible to identify the "best guess" and the "worst case" scenarios. In the best guess scenario, it is expected that drier conditions at the beginning of the rainy season will delay its onset, but will be compensated by wetter conditions later on, resulting in increasingly erratic rainfall patterns. In the worst-case scenario, it is expected that there will be an increase in rainfall intensity, a decrease in the frequency of rainy days, a delay in the onset of rains, and a decrease in the length of the rainy season. This would result in persistent drought. Both scenarios would have detrimental impacts on people's food security in Mali.

FIGURE 14

Proportion of income derived from climate-sensitive activities in Mali (the desert is masked)



Source: *Comprehensive Food Security and Vulnerability Analysis, Mali 2007.*

Changes in rainfall could significantly exacerbate food insecurity in Mali with detrimental impacts on people who are already food insecure.

NEPAL

Climate risk and food security in Nepal: Analysis of climate impacts on food security and livelihoods, 2013

Partners: *WFP and the CGIAR research programme on Climate Change, Agriculture and Food Security (CCAFS), with funding support from Sweden and Luxembourg*

Recent climatic events, including the 2008 floods and the 2008-2009 winter drought, highlight that Nepal's food security is highly sensitive to climate risks. This analysis found that the most vulnerable communities to climate risks are located in the mid- and far-western regions of the country, where the majority of rainfall occurs during the winter months. Climate trends suggest that winter rainfall is decreasing - especially in these areas. Communities in the mountain district of Humla (Far-Western Development Region), for instance, reported that recent variability in the start and duration of the rainy season is affecting their crop production.

A continuation of this trend may have major impacts on the lives and livelihoods of people in these areas, especially in terms of food access. Reduced winter crop production due to lower post-monsoon precipitation would force households to reduce consumption from domestic sources and purchase more of their food. In addition, climate-induced food price volatility could require households to spend more of their income on food.

Impacts of climate change are not limited to reduced water availability. The Eastern flatlands (Terai), which are the most productive areas of Nepal, are also highly vulnerable to increased flood risk. Communities in these areas may see reduced rice yields due to intense rainy seasons. As this region produces rice for various parts of the country, reduced yields may also impact on food prices at the national level.

This analysis has helped to better understand that at-risk populations are highly dependent on markets and vulnerable to volatile food prices. In this context, buffers against food insecurity may benefit from the use of subsidies to stabilise food prices during shocks, alongside building food stocks and enhancing people's access to markets. Innovative strategies such as weather-index insurance schemes could also protect vulnerable farmers against the negative impacts of climate variability, while conditional asset transfers for stabilisation, landscape management and disaster mitigation infrastructure could reduce disaster risks. Given the high reliance on rainfed agriculture, strategies for livelihood and income diversification are also critical to ensuring resilience.

FIGURE 15

Precipitation trends in different regions of Nepal, 1976-2005

	Development Regions					
	Mid- and Far Western			Western, Central and Eastern		
	Terai	Hills	Mountains	Terai	Hills	Mountains
Monsoon	Decrease	Decrease	No change	Increase	No change	No change
Post-monsoon	Decrease	Decrease	Decrease	Increase	Increase	Decrease
Annual	Decrease	Decrease	Decrease	Increase	Increase	Decrease

Source: *Practical Action, 2009*

PHILIPPINES

More intense Typhoons: What does a changing climate mean for food security in the Philippines? 2015

Partners: *WFP; with funding support from Sweden*

Despite impressive progress to address poverty and food insecurity in the Philippines, climate-related hazards could threaten these hard-won development gains. Typhoon Haiyan, which hit the central part of the country in November 2013, and more recently Typhoon Hagupit in 2014 are testament to the potentially devastating effects of climate on food security and vulnerable livelihoods. Better understanding of climate risks and their impact on household food security is a critical first step for managing and reducing risks. This thematic report examines the links between climate risk and food security, and should be used to initiate discussion about appropriate interventions.

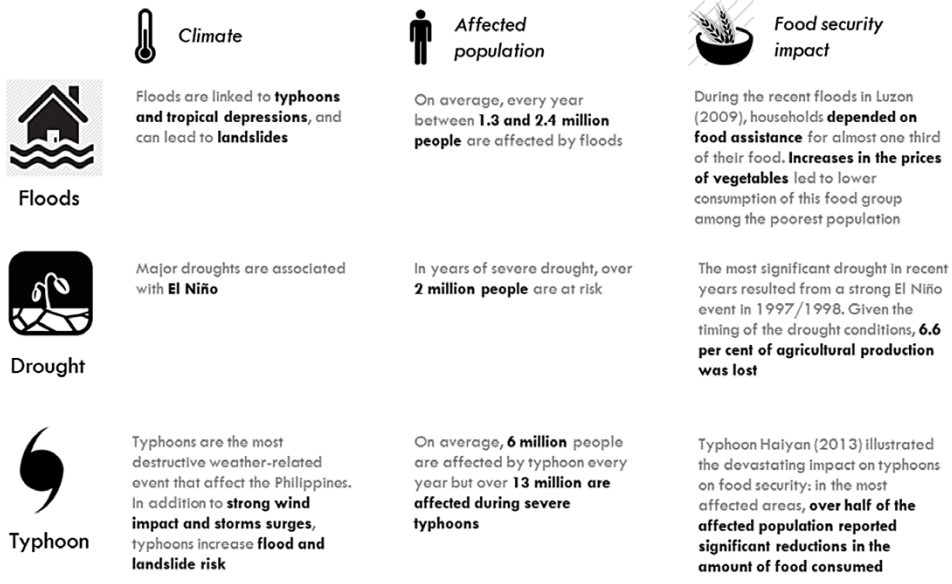
The report shows that climate is a key driver of food insecurity in the Philippines, linked to four key risks:

- **Higher Typhoon intensity**. Typhoons are expected to occur less frequently but be more intense. This trend would have particularly detrimental effects in the north of the country which has been historically the most frequently affected.
- **Sea-level rise.** Sea levels are expected to rise by up to 50 cm by the end of the century. In addition to causing damages to coastal livelihoods, rising sea-levels could also increase the damage of storm surges.
- **Drought risk.** Climate projections suggest a decrease in rainfall in parts of Luzon and Mindanao during the dry season (March-May), which combined with higher temperatures can lead to increased drought risk. As these areas are predominantly agricultural, drought could have a devastating effect on livelihoods.
- **Flood risk.** The wet season is expected to receive more rainfall in most parts of the country with potentially more frequent and intense floods. The largest increases in rainfall are predicted over the Visayan Islands.

Given the potential loss and damage that could result from climate change in the Philippines, the report highlights that focus should be given to managing these impacts, including through disaster preparedness, better early warning systems, asset creation, support to social protection and risk transfer mechanisms. Urban food insecurity is also an emerging challenge. More than half of the Philippine population is expected to live in urban areas by 2020, but while urbanization can offer new opportunities, food insecurity remains quite high among the poorest urban dwellers.

FIGURE 17

The Philippines is highly susceptible to climate-related hazards



To view this figure in more detail, please visit: https://docs.wfp.org/api/documents/WFP-0000023397/download/.

PHILIPPINES

Is the Fun Drying Up? Implications of Intensifying El Niño Conditions for Drought Risk & Food Security, 2016

Partners: *WFP with funding support from Sweden*

The Philippines is traditionally associated with typhoon impact. However, other weather events affect the country and threaten food security and nutrition. The El Niño phenomenon, for instance, is associated with lower rainfall between December and February which can have severe effects on the second cropping cycle and can deplete water resources for the main cropping cycle. This analysis focused on reviewing the potential impacts of the El Niño phenomenon on food security based on historical data of the previous 1995–1996 El Niño event and analysed the key concerns of droughts under climate change.

The study indicates that over the 20th century, the Philippines has experienced a number of serious droughts linked to El Niño that have had major implications for food security. Historically, El Niño-induced droughts have resulted in severe agricultural losses of over 6 percent with key crops such as rice, maize and coconut being particularly affected. Under climate change, increased warming and more erratic rainfall patterns could exacerbate drought risk, particularly if combined with a delay in the onset of rains.

Some of the main findings point out that since early 2016, over 85 percent of the territory was considered to be affected by the dry conditions brought about by El Niño, with Mindanao being the most affected. As a result of below-average rainfall conditions throughout the Philippines, some areas experienced severe water shortages which would affect agricultural production.

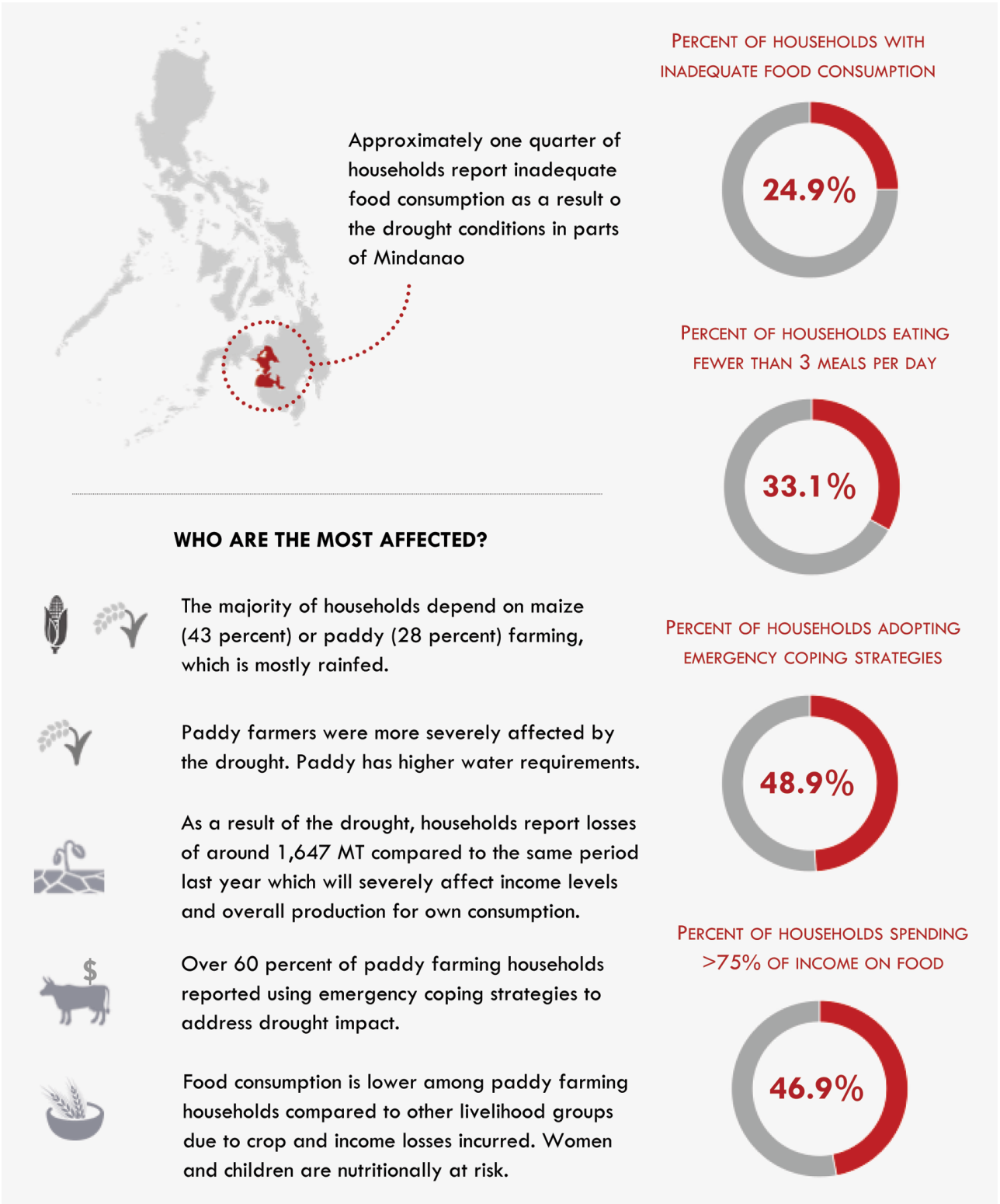
The analysis underlined that actual impacts are not possible to forecast since those depend on a number of factors including the preparedness measures taken by communities. Based on information from the emergency food security assessment conducted by WFP in March 2016 in Lanao del Sur and Maguindanao – some of the most affected provinces – high food security impact was revealed.

A key concern under a climate change scenario is that warmer sea surface temperatures may result in more frequent and stronger El Niño periods. More powerful episodes could result in longer and more intense reductions in rainfall. This trend, together with potentially more intense typhoons could have devastating consequences for agricultural production and food security. Other concerns included warmer temperatures, especially in the summer months, exacerbating the risk of drought in the months leading up to the monsoon rains.

It is acknowledged that several adaptation measures have already been taken by the Government of the Philippines and communities to reduce the potential effects of the drought including introduction of water harvesting technologies and vegetables instead of rice. In addition, the report indicates that addressing the recurring risks associated with El Niño will require investments in early warning and preparedness, adaptation strategies and risk management techniques ensuring support to the most vulnerable.

FIGURE 18

Impacts of drought to food security in Mindanao, the Philippines



Source: *WFP Emergency Food Security Assessment (2016).*

SENEGAL

Climate risk and food security in Senegal: Analysis of climate impacts on food security and livelihoods, 2013

Partners: *WFP, National Agency for Civil Aviation and Meteorology of Senegal (ANACIM), and Columbia University's International Research Institute for Climate and Society (IRI); with funding support from Sweden, Luxembourg and the CGIAR research programme on Climate Change, Agriculture and Food Security (CCAFS)*

This analysis finds that all rural livelihood systems in Senegal are highly sensitive to climate given their dependence on rainfall. Recent climate trends show that climatic conditions that aggravate food security are concentrated in the central parts of the country. These regions experience irregular rainfall patterns during the rainy season, an erratic start of the rainy season, and long dry spells that could affect crop production. Climate projections suggest that these trends could continue over the next few decades.

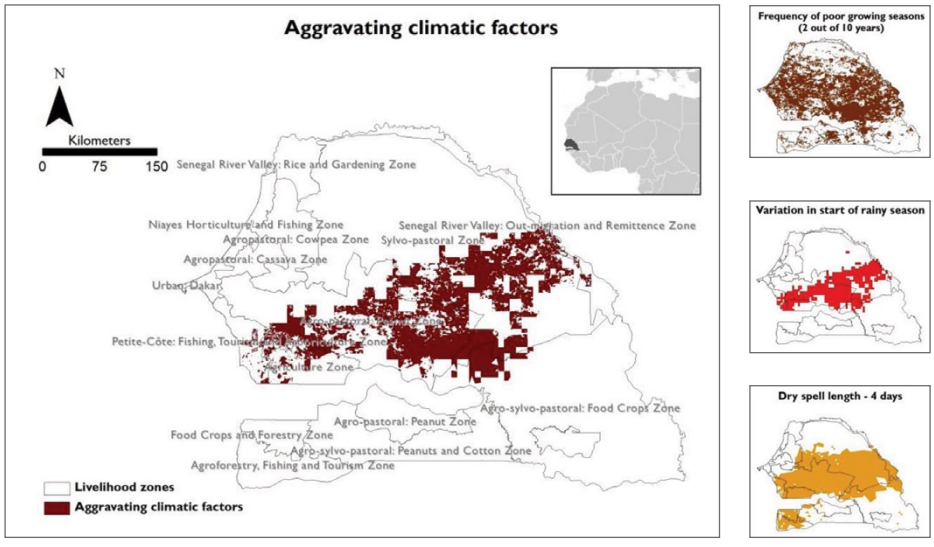
Access to markets is critical to food security in Senegal. Two inter-related climatic impacts could affect the ability of households to access food during critical months. First, if the lean season intensifies due to climatic variability, it is likely that households would have to purchase more of their food during the lean season. Second, under a scenario of increasingly erratic rainfall, extreme climate events such as floods could destroy or severely affect infrastructure, reducing the ability of households to purchase food. Infrastructure is a key aspect, especially in the southern parts of the country where access to markets is critical for ensuring household food security.

Rainfall is the key climatic determinant of food production in the country. Climate change is characterised by high rainfall variability at seasonal, inter-annual and multi-decadal scales, and is one of the main contributors to food insecurity in the key agricultural areas in Senegal. Historically, climate change in Senegal was linked to persistent drought in the 1970s and the 1980s. Recent observations suggest a reversal of these conditions with higher precipitation because of increasing rainfall intensity rather than frequency. The rainfall patterns are highly erratic in Senegal and can result in a more uncertain risk environment in the future.

The analysis highlights that integrating climate risk management structures into broader development pathways offers a cost-effective manner of addressing multiple development challenges, while accounting for the emerging risks posed by climate variability and change. Social protection and safety nets provide critical platforms for investing in risk management for the most vulnerable and should become a policy priority.

FIGURE 19

Areas in Senegal affected by poor growing seasons, variation in start of raining season and moderate dry spell length



Source: *SPOT-VGT, 2012; USGS, 2012*

SRI LANKA

Consolidated Livelihood Exercise for Analysing Resilience (CLEAR), 2014

Partners: *WFP and Ministry of Economic Development; with funding support from Sweden*

Sri Lanka is exposed to a diversity of climate-related hazards, including floods, droughts, landslides and storms. Extreme climate events can have detrimental effects on livelihoods and food security. Historical trends suggest that the number of people being affected by climate-related hazards is increasing, from an average of 400,000 people affected every year between 1980 and 1990 to an average of 750,000 affected annually between 2000 and 2013. The majority of the affected population is exposed to drought or flood - both of which are linked to failure or high intensity of the monsoon rains. The increase in exposure is largely due to erratic monsoon patterns resulting in more frequent and intense floods and droughts. In addition to increasing magnitude, recent evidence suggests that both hazards are occurring where they typically do not.

In recent years, the northeast monsoon has been delayed or collapsed altogether, resulting in insufficient rainfall for rice production – particularly in the Central and North-eastern provinces. As these regions produce most of the rice consumed in-country, the impacts on food prices and consequently on food security at the national level are significant. In addition, affected farmers may be impacted through reduced income.

Climatic shifts, particularly in eastern Sri Lanka, threaten traditional rainfed agriculture. Data indicates that since the 1970s, rainfall has shifted westward, reducing the amount of rainfall reaching the easternmost parts of the country. This region depends primarily on rainfed agriculture and is therefore vulnerable fluctuations in the amount and duration of rainfall.

Projections of sea-level rise suggest increases in global sea-levels of up to one metre. Such sea-level rise has the potential to inundate the entire coastal area, affecting primarily fisher folk through loss of land, higher erosion, and increased risk of storm surges. Moreover, salt intrusion as a result of sea-level rise can affect farmers further inland.

This analysis has helped to highlight that the focus of current food security interventions - where greatest food insecurity is known to exist - is not aligned with where future climate-induced food insecurity would occur. This has implications for the targeting of climate change policies and programmes focused on food security.

In Sri Lanka, historical trends suggest that the number of people being affected by climate-related hazards is increasing. The majority of the affected population is exposed to drought or flood—both of which are linked to failure or high intensity of the monsoon rains.

FIGURE 20

Examples of potential impacts of climate change on food security and livelihoods in Sri Lanka

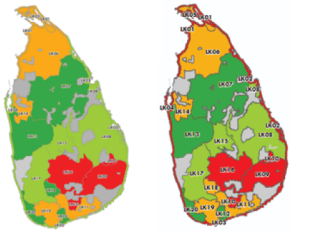
Sea-level rise

Sea levels are expected to rise by up to 50 cm over the next 30 years, submerging some low-elevation coastal areas and accelerating saltwater intrusion into productive lands. The extent of loss and damage is difficult to quantify as there would be losses to settlements as well as livelihoods in areas affected by saltwater intrusion.

The most direct effect of sea-level rise would be on fisherfolk who would lose their houses as well as some of their key assets. Some agricultural livelihoods in the Jaffna peninsula would also be rapidly affected due to saltwater intrusion.

Sea-level rise would also exacerbate loss and damage resulting from storm surges and typhoon risk – particularly in the northeastern parts of the country.

Current food security status	Food security L&D scenario



Food security implication: deterioration of food security in coastal areas

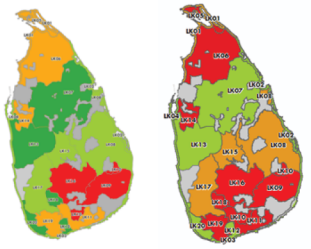
Monsoon collapse

Agriculture in the Mahaweli mixed farming & livestock zone is possible due to an extensive network of micro-tanks which allow for irrigation even during the dry months.

However, recent erratic weather patterns have highlighted that this type of irrigation practices may not be feasible if rainfall in the highlands does not replenish the water tanks. Climate trends suggest that the northeast monsoon is becoming increasingly erratic, resulting in crop and income losses for the poorest farmers. Future projections of climate suggest that consecutive drought seasons may occur if both monsoon seasons collapse.

This is of particular concern given that a large proportion of the rice produced in the country originates from this zone. Significant losses in production could have devastating effects on the food security of the entire population.

Current food security status	Food security L&D scenario

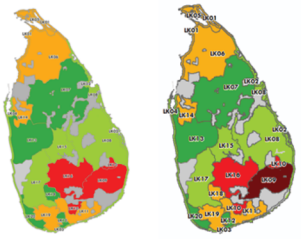


Food security implication: deterioration of food security across the entire country

Climatic shift

Households in the southeastern rainfed paddy & OFC zone depend primarily on rainfall for their agricultural production. This livelihood zone is located across the dry, intermediate, and wet climatic zones. According to recent climate trends, the intermediate and wet climatic zones are shifting westward, resulting in an expansion of the dry zone. A continuation of this trend would render rainfed agriculture unfeasible in the future, and households would lose their primary livelihood option.

Current food security status	Food security L&D scenario



Food security implication: deterioration of food security across an already highly vulnerable zone

SOUTH SUDAN

Climate risk and food security in South Sudan: Analysis of climate impacts on food security and livelihoods, 2014

Partners: *WFP, Famine Early Warning System Network (FEWSNET), with funding support from Sweden*

A number of recent events examined in this analysis highlight the sensitivity of livelihoods in South Sudan to climate-related risks. This includes floods in 2013 and 2014, droughts in 2008, 2010 and 2011, civil war between 2013 and 2014, inter-communal conflicts and cattle rustling, and increasingly erratic weather. Rainfall is one of the main climatic determinants of food production in South Sudan. Consequently food security, particularly in the most vulnerable areas in the arid and semi-arid lands of the country, is highly sensitive to climate risks. The driest part of the country includes the semi-arid areas of the south-eastern region, coinciding with the highest food insecurity levels. Whereas some parts of the southern and central regions have experienced a decrease in rainfall, other parts in the western and eastern regions have experienced an increase in rainfall. In addition, there has been a shift to late onset and early cessation of rainfall together with more erratic and unpredictable patterns.

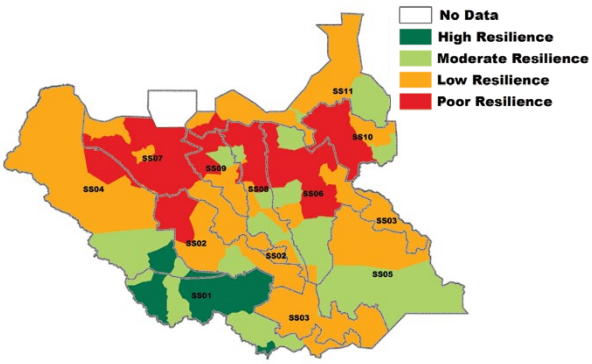
Access to markets is critical for food security in South Sudan, especially during lean seasons. If seasonal rainfall declines or is poorly distributed, food access would be affected in two inter-related ways. First, reduced crop production would force households to purchase more food. Second, climate-induced food price volatility could require households to spend more of their income on food. In addition, climate-related disasters such as floods limit physical access to markets.

This analysis highlights that most parts of South Sudan have low resilience to a number of risks. Conflict-prone areas are particularly vulnerable, with protracted conflict exacerbating early depletion of household food stocks, dysfunctional markets, loss of livelihoods and displacement. Households in areas exposed to multiple hazards and that depend solely on pastoralism with limited livelihood diversity also have poor resilience, often being predisposed to livestock disease and cattle rustling. Most of the poor households in the central parts of the country who depend on rainfed agriculture and related activities face chronic poverty and very low diversity of livelihoods. The frequency of a multiple set of hazards, combined with people's heavy reliance on difficult to access to markets also exposes people to high risks of food insecurity and poor household resilience.

Unless considerable efforts are made to improve people's resilience, the risk of hunger and child malnutrition could increase by up to 20 per cent due to climate change by 2050 (Perry et al 2009). In the picture, beneficiaries with food rations at a WFP distribution site in Ganyiel, South Sudan.

FIGURE 21

Resilience of different livelihood zones to climate risks in South Sudan



SUDAN

Climate Change and Food Security Assessment in Sudan, 2016

Partners: *WFP, Met Office Hadley Centre, with funding support from Sweden*

As part of WFP's efforts to understand how climate change will impact food security in Sudan, WFP partnered with the UK Met Office Hadley Centre to undertake this analysis. The objective was to explore the relationship between climate and food security under three different and plausible scenarios of climate change that span the range of model projections for Sudan. The climate model projections have been applied to three different climate and livelihood zones to investigate the impacts on food security across the country.

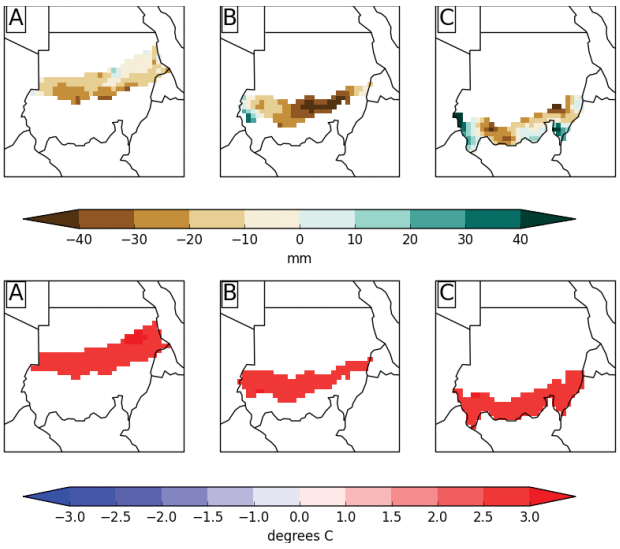
The results of the Food Security and Climate Change Assessment are very telling. The different climate change projections all indicate a substantial increase in warming, resulting in increased heat stress, and reductions in water availability, as well as continued rainfall variability, making food production more challenging. Temperature increases of 1.5 to 3°C are expected, making a considerable difference to agricultural production.

Associated challenges include increased evaporation, shortages of water, and possible pest outbreaks. The report's main conclusions include:

- **Food security and climate are closely linked in Sudan.** Agriculture accounts for around one third of Sudan's GDP and employs around 80 percent of the labour force. Agriculture is mostly rainfed and is therefore sensitive to rainfall amounts and timings, making climate variability and change key factors in the future of Sudan's economy, livelihoods, and food security.
- **Sudan's climate is hot through the year, with seasonal rains.** There is a north-south rainfall gradient and variability in annual rainfall amounts. Sudan lies at the northern most extent of the Inter Tropical Convection Zone and therefore has a strong gradient of rainfall. Rainfall amounts also vary from year-to-year depending on the position and intensity of the zone.
- **Livelihoods and agricultural production systems correspond to the climatological suitability of the region.** Pastoralism dominates in the north where rainfall totals are low and the onset of the rains is unreliable; cropping systems are more prevalent in the south where the rainy season is reliably longer and heavier.
- **Climate model projections for the 2040s show strong agreement for an increase in temperature, but no strong signal for changes in rainfall.** Climate change projections for Sudan indicate a substantial warming trend across the country. In contrast, rainfall projections are mixed, with most models projecting small increases in annual rainfall and some projecting small decreases. However, increased evaporation as a result of higher temperatures will have a negative impact on water availability.
- **All scenarios of projected climate change will result in increased heat stress, reductions in water availability, and continued variability, making food production more challenging.** The three scenarios showed varying extents of increased heat and water stress, and variability in timings and amounts of rainfall.

FIGURE 22

Projected change in Sudan's average annual rainfall (top panels) and the average daily maximum temperature (bottom panels) for the 2040s relative to a 1981-2010 baseline



Source: : *UK Met Office.*

- **The climate projections can be thought of as a southward shift of the current climate to varying extents in each scenario.** The concept that the future climate is analogous to a hotter version of the climate further north could be helpful to inform adaptation planning.

With these results, the Government of Sudan and relevant stakeholders are now undergoing consultations which will help ensure that strategies and national adaptation plans take into account expected changes in the climate and that programmes are risk informed.

Sifting and storing grains following harvest in Sudan.

TAJIKISTAN

Tajikistan Integrated Context Analysis, 2015

Partners: *WFP, with Committee of Emergency Situation and Civil Defence; funded by Sweden*

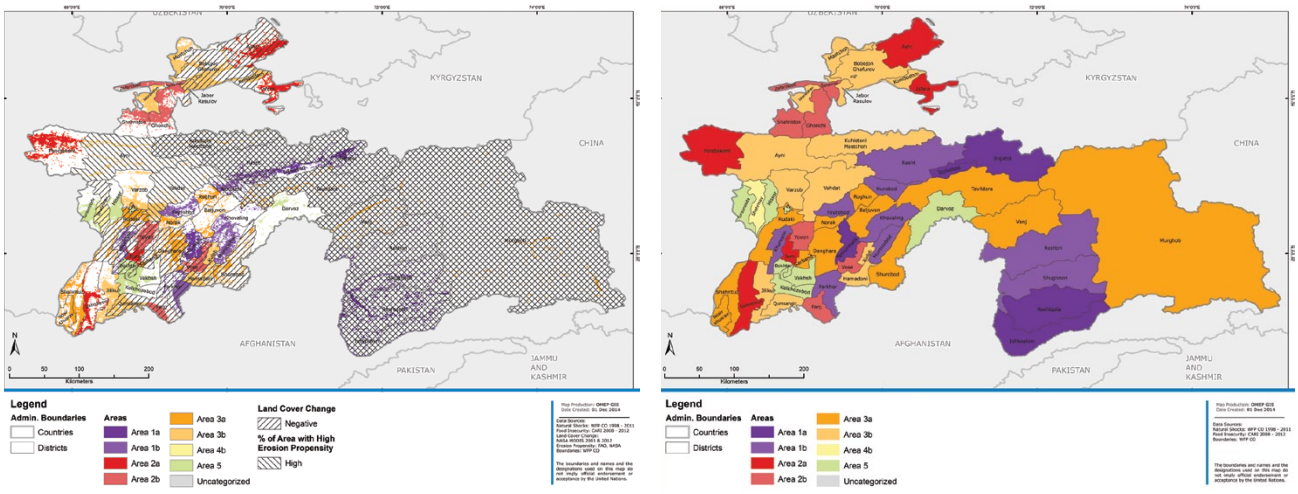
WFP's Tajikistan office has been using an adapted integrated context analysis (ICA) tool that was developed to explore historical trend analyses of existing data on food insecurity, natural shocks and land degradation. Initial findings from this analysis shows that that people in Tajikistan are exposed to a high degree of volatility in food security. The frequent recurrence of food insecurity is often seasonally influenced, especially in the central and eastern parts of the country where potato and livestock livelihoods are respectively practiced. Climate risks vary differently across the country, although people living in the central and western parts of Tajikistan more typically suffer from droughts, floods and landslides. In 2011 to 2012, erratic rain led to low crop production, which was further worsened by disruptions to electricity for irrigation pump schemes.

A major determinant of food insecurity in Tajikistan is related to food access concerns, including the cost of food in markets. In the poorest rural households, about 80 percent of food expenditures is from income derived from remittances. Remittances represent more than 50 percent of national GDP, which is one of the highest in the world, resulting in high vulnerability to economic shocks translating to food price spikes. Such vulnerability was observed during the food and fuel price crisis of 2007 to 2008, when remittances decreased significantly with severe implications on household food security. The situation is further aggravated when coupled with very high recurrence of natural shocks such as floods, droughts and landslides, alongside extreme land degradation in many parts of the country.

This analysis has been particularly useful in strategically guiding the design of appropriate interventions, both through its categorisation of trends of food insecurity and natural shocks, as well as the analysis of additional layers such as seasonality, malnutrition, and livelihoods. The analysis categorisation provides recommendations on prioritising intervention sites as well as types of intervention required. This includes, for example, identifying where seasonal food insecurity needs are greatest, and where medium-term protracted crisis programming or longer-term resilience and climate change adaptation programmes are critical. Additional tools and processes further help to determine specific partners, areas of intervention and activities at various levels.

FIGURE 23

Recurrence of food insecurity and climatic shocks in Tajikistan, using integrated context analyses overlaid with population density



TIMOR LESTE

Consolidated Livelihood Exercise for Analysing Resilience (CLEAR) in Timor-Leste, 2016

Partners: *WFP, Ministry of Interior, the Ministry of Agriculture and Fisheries, the Ministry of Social Solidarity, the Ministry of State Administration, the Ministry of Commerce, Industry and Environment, the Ministry of Finance; with funding support from Sweden*

This analysis was carried out at the request of the Government of Timor Leste to better understand how the 2015 to 2016 El Niño drought affected different livelihoods, focusing on the most vulnerable households. In the immediate term, the results of the analysis were used to guide the Government and WFP's El Niño response, while in the longer term, they are being used to inform national disaster risk reduction efforts.

Fields affected by the 2015/16 El-Nino-induced drought in Timor-Leste

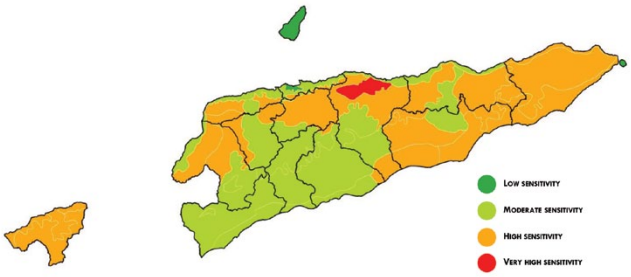
The analysis shows that despite being a relatively small country, livelihoods in Timor-Leste are diverse, owing to a complex topography and the bimodal rainfall pattern in the southern coast. The livelihoods with greatest climate resilience are those with sufficient access to financial capital, those which are highly diversified, and those which rely on less climate-sensitive crops.

Generally, livelihoods in the eastern, northern and Oecussi zones have the lowest climate resilience, due to a combination of low income levels, low livelihood diversification, and high sensitivity to rainfall changes. Those in Dili, Atauro and the southern coast have greater access to diverse livelihood options and are therefore more resilient to climatic shocks.

Climate change is one of the key challenges threatening livelihood stability. Projected changes in rainfall and temperature offer risks as well as opportunities for diversifying livelihoods into more resilient systems.

FIGURE 24

Climate sensitivity of income by livelihood zone in Timor-Leste



Limited access to irrigation means that livelihoods are generally sensitive to the effects of climate variability: delays in the onset of the rainy season can affect key stages of crop growth thereby affecting yields leading to food and income losses. Diversification towards less sensitive crops such as sweet potato and coffee reduces climate sensitivity. Households engages in activities that do not depend on rainfall, such as tourism, are less climate-sensitive.

Source: *Based on analysis of crop sensitivity by IIASA and FAO (2012) Global Agro-ecological Zones.*

UGANDA

The Impact of Climate change on food security and livelihoods in Karamoja, 2016

Partners: *Uganda National Meteorological Authority, the CGIAR research programme on Climate Change, Agriculture and Food Security (CCAFS) and WFP; with funding support from Sweden*

This analysis was conducted within Karamoja in the northeast of Uganda, examining climatic trends over the past 35 years, as well as conducting household surveys within the region. The region's population is highly dependent on subsistence agriculture, which is sensitive to climate conditions, making agriculture one of the most vulnerable sectors to the impacts of climate change. As a result, the region suffers chronic food insecurity due to the combined impacts of high levels of poverty, low human development and unfavourable climatic and weather conditions.

Average monthly rainfall in Karamoja has increased over the last 35 years. However, the variability of monthly rainfall over the same period has also increased. This increase in variability will likely perpetuate the historic trend of unpredictable and unreliable rain, leading to an increase in the frequency of periods of low/no rainfall and heavy rainfall events. With low efforts in climate change adaptation in the region, increased rainfall variability will have a detrimental impact upon agricultural production, exacerbating the already elevated levels of food insecurity in the region.

The analysis shows that the average monthly rainfall and temperature in Karamoja has increased over the last 35 years, with also evidence of an emerging late rainfall phase in Karamoja as a result of increased rainfall during September, October and November could potentially extend the growing season. There is however a corresponding increase in rainfall variability over the same period. Rising temperatures will impact households directly through the increased frequency, intensity and duration of heat waves and reduced water availability, and also detrimentally impact agricultural and livestock production in the region, exacerbating food insecurity.

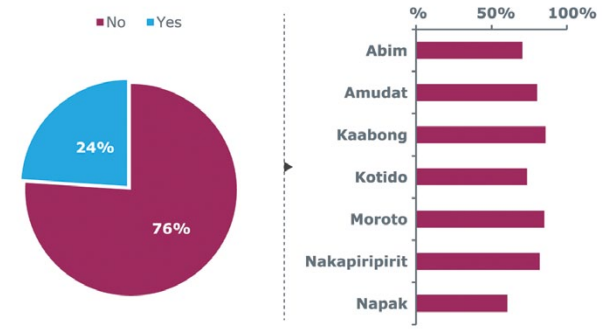
Owing to an increase in extreme weather events and variability of weather patterns, climate change is expected to negatively affect food security outcomes, potentially affecting all four dimensions of food security as shown below.

Uganda. For WFP, building resilience is about enhancing and reinforcing the capacities, livelihoods and opportunities of the most vulnerable and food-insecure people, communities and countries in the face of an increasingly risky environment.

FIGURE 25

Household survey results highlighting in Karamoja: (a) respondents who made changes to protect themselves, family or community against climate change; (b) reasons for respondents who did not make changes; (c) changes made by respondents who did make changes; (d) adaptation rates amongst respondents who were or were not part of an informal/formal group

a



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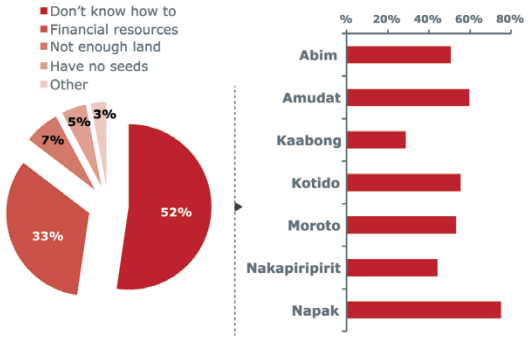

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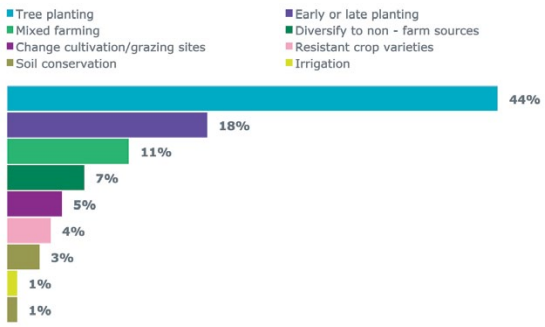

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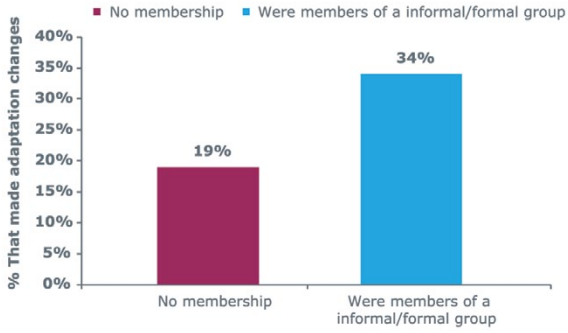


A survey of households conducted among food insecure populations in Karamoja found that climate and weather shocks deteriorate livelihoods and undermine the capacity of households to adapt to moderate shocks and people's ability to produce and purchase food - increasing their vulnerability to food insecurity and placing them at need for assistance. Nearly three-quarters of respondents cited droughts or prolonged dry spells as having impacted their households in the last five years. However, the same number of respondents have not made changes to adapt to the impacts of climate change, with the main reason being not having knowledge of how to adopt such practices. The most popular adaptation measure cited was tree planting, while begging, borrowing, and the sale of local brews, charcoal and firewood were the most frequently cited coping strategies.

The survey also examined gender differences in coping mechanisms and adaptation practices, with one recommendation highlighting the need to focus on mainstreaming gender into climate interventions, especially in relation to women's access to climate information services. Other recommendations included to: sensitize households to climate threats; implement and upscale initiatives that promote drought resistant crops; to increase membership to formal and informal village groups; and to encourage agro-forestry, and water harvesting and conservation.

5. Methodologies and lessons learnt from food security climate analyses

The impacts of climate change on food insecurity vary significantly across the world – a reflection of the range in geographical, political, social and economic contextual challenges of each region.

Having a variety of methodological approaches at hand encourages more flexibility in examining climate vulnerability in different settings, thus providing governments and international actors with more tailored analytical tools for their specific needs. The C-ADAPT initiative has allowed WFP staff and partners to experiment with a range of different methodologies, helping them to draw lessons across various contexts, to fine-tune approaches, and to find opportunities to mainstream these into other tools and approaches. An overview of some of these methodologies, and lessons learnt from each, are presented below.

Climate risk and food security analyses have been used in Ethiopia, Kyrgyz Republic, Mali, Nepal and Senegal. The methodology used has consisted of two stages. The first stage focuses on defining the purpose and scope of the study, and identifying data requirements and availability. The second stage consists of a climate vulnerability analysis (including historical climatology, current climate variability, and future climate change projections), baseline vulnerability assessment, a long-term historical analysis (with climate and food security data), and a workshop with partners to validate the results.

Current lessons learnt from these analyses are largely related to data collection and availability. In many cases there has been a lack of long-term data on key indicators, especially on nutrition, often because this information was not collected in the past. Such research limitations for nutrition have also been identified by the World Health Organisation (WHO) and the Intergovernmental Panel on Climate Change (IPCC).[5] Data is also often spread among different institutions or it is not available to the public. Challenges in data processing can also arise, for example, in discerning the difference between the Gregorian and the local calendars; the majority of meteorological data are aligned to the Gregorian calendar, while time series data collected by government ministries are often aligned to local calendars.

Assessing the contribution of different climate factors to food insecurity can also be challenging, as some factors that are affected by climate are difficult to quantify but are critical to understanding food security in vulnerable settings. These factors include, among others, adaptation strategies already implemented by farmers (which in turn could be a response to climatic changes and could therefore lag behind climate trends), access to markets (which is very specific to households), and livelihood assets (which are also very specific to households).

Non-climatic factors are also important to accurately determine the conditions that influence food security. For example, food prices are influenced by imports and global trends, which may not always be related to climate. Identifying these non-climatic factors would provide a more nuanced understanding of climate impacts on food security.

In line with the above, climate risk and food security analyses have been particularly challenging to link to strategic programme recommendations which often requires a stronger focus on examining livelihoods (administrative boundaries are often used), their specific climate sensitivities and existing adaptive capacities. On the other hand, this analysis often has had the benefit of being more precise and devoting more space to highlighting historical climate trends.

5. Phalkey, Revati K., Clara Aranda-Jan, Sabrina Marx, Bernhard Höfle, and Rainer Sauerborn, 2015, *Systematic review of current efforts to quantify the impacts of climate change on undernutrition, Proceedings of the National Academy of Sciences* 112, no. 33: E4522-E4529.

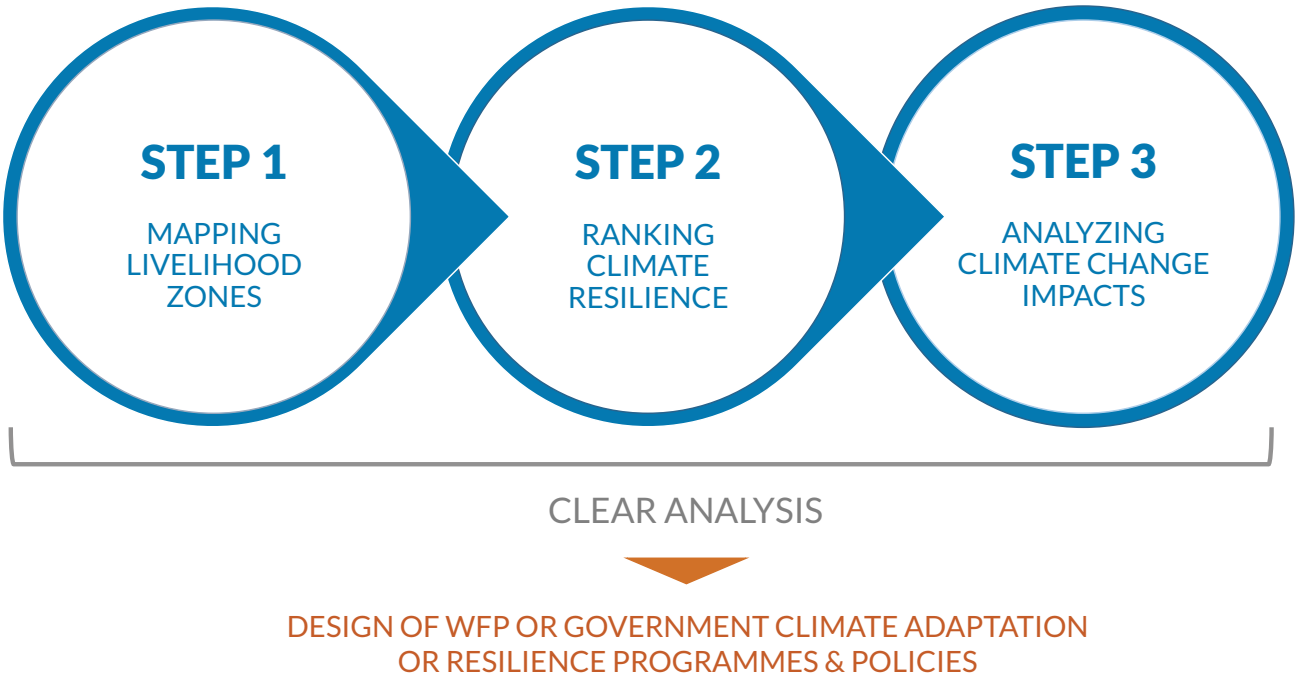
Another lesson learnt in undertaking these methodologies is the importance of working hand-in-hand with government and partners in both designing and carrying out these analyses, helping to build technical capacities of government counterparts for future analysis efforts. This joint work requires a more inclusive set of questions to be incorporated into the analysis exercise from the start, ensuring different information needs are more efficiently met, while also building trust in sharing data and assisting with wider buy-in with the final results.

The **Consolidated Livelihood Exercise for Analysing Resilience (CLEAR)** is a methodology that has been developed by the WFP Asia region to better understand how food security is affected by climate risks, whether they be related to extreme events (such as droughts, floods and cyclones), or to long-term gradual changes (such as shifting rainfall patterns, rising temperatures, or salinity intrusions in coastal areas due to sea level rise). The ultimate objective in applying this methodology is to inform the design and targeting of programmes and policies related to climate change adaptation, by shedding light on how both current and future climate risks affect the most vulnerable people.

A defining feature of the CLEAR approach is that it takes livelihoods as the starting point: livelihood zones, rather than administrative boundaries, are used as the main analytical unit. Focusing on livelihoods means the priority is placed on communities and what they do for a living. This helps understand how climate affects people, rather than geographic areas.

FIGURE 26

Basic steps for undertaking a Consolidated Livelihood Exercise for Analysing Resilience (CLEAR) analysis



CLEAR should not be considered a fixed method, but rather an approach to food security and climate risk analysis that can be modified to suit different analytical needs and socio-economic contexts, while still maintaining its core emphasis on livelihoods.

Nevertheless, CLEAR analyses are guided by a common approach, in identifying and overlaying three types of information: (i) a map of livelihood zones; (ii) a ranking of the resilience of different livelihoods to climate risks; and (iii) an assessment of the impacts

Long-term adaptation requires applied knowledge to streghthen local and national systems' capacity.

of future climate risks on livelihoods and food security. The analysis thus typically involves three steps: livelihood zoning in consultation with local and national stakeholders, resilience analysis, and analysis of climate change impacts. In each of these steps, data is collected through a combination of secondary sources (topography and agro-ecological maps, poverty and food security surveys, climate information from meteorological agencies, etc.), government consultations at the national level, and community consultations at the field level.

The CLEAR analysis has already been carried out in Afghanistan, Cambodia, Laos, Nepal, Sri Lanka, Sudan and Timor-Leste and are in the process of being carried out in Vietnam and the Pacific region. In each country, CLEAR has been used differently. In Cambodia, CLEAR findings were integrated into WFP's existing online food security monitoring platform. During the dry spell of the 2015 summer rainy season, this proved extremely useful to understand which areas were most at risk of becoming food insecure if the dry spell turned into an extensive drought, helping WFP estimate how many people would be highly impacted. In Timor Leste, CLEAR helped to better understand how the 2015 to 2016 El Niño drought was affecting different livelihoods, with the immediate results used to guide the Government and WFP's El Niño response, while in the longer term informing national disaster risk reduction efforts. Lessons from this approach has allowed WFP to publish guidance on applying the CLEAR methodology.

The Integrated Context Analysis (ICA) is a tool that has been developed by WFP to explore historical trend analyses of existing data on food insecurity, natural shocks and land degradation. Identifying areas of overlap across these dimensions helps to inform discussions from a variety of stakeholders on the most appropriate programmatic strategies in specific geographical areas, and aims to provide a neutral basis for additional, more detailed thematic analyses as needed. The ICA considers historical data on floods and droughts through contextually relevant proxies, such as rainfall estimates, number of poor growing seasons, and the use of national datasets when available.

A number of countries using the ICA method have been exploring additional climate indicators to understand the impacts of climate risks and climate change on vulnerable groups. Each country has varied in their approach; some of these countries have been limited by having mainly crop production statistics to work with, but little other food security data such as food access issues (including food consumption and market prices). Unless additional analysis using climate projections is applied with the ICA, the tool is more limited in its ability to examine beyond climate risks to longer-term climate change impacts. A benefit of the ICA is that it is better equipped to inform project design, given the tool is designed to support this.

The Shock Impact Simulation Model (SISMod) is a modelling system to analyse the outcome of shocks (economic, market and production) on food security.

The system helps estimate people's needs for food assistance across population, livelihood groups and areas in selected low-income and food-deficit countries. The tool combines data sets from the World Bank, FAO, WFP and national sources on key household/livelihood, economic, market and production data to model the effect of various key shock factors.

Experimentation has been applied to a number of countries to model climate shocks. The main challenges to date have been in collecting and compiling an adequate time series of data; particular data, including food security and climatic information has not always been available for a long enough time to produce reasonable projections into the future. Establishing context-specific scenarios also requires fine-tuning in each country to which the shock model is applied. To be able to implement this approach in the future, more work would be needed on developing guidance and readily formatted data for staff and partners to undertake these analyses on their own.

The Food Insecurity and Climate Change Vulnerability Index has been developed by the UK's Met Office Hadley Centre and WFP to examine current and projected levels of countries' vulnerability to food insecurity. The methodology is based on an adaptation of the Hunger and Climate Vulnerability Index .[6] Vulnerability is defined by a composite index based on measures of exposure, sensitivity and adaptive capacity:

- **Exposure** to climate-related hazards is measured using indicators derived from meteorological data, including the average length of drought and flood events.
- **Sensitivity** is measured using indicators of forest coverage, prevalence of agriculture that is rainfed and yields of cereal crops.
- **Adaptive capacity** is based on indicators describing the population's access to water, share of roads that are paved, government effectiveness, growth rates of the population, poverty headcount rates, share of labour force in vulnerable employment and rural share of the total population.

6. Krishnamurthy P.K., Lewis K., Choularton R.J. K. Lewis (2014) A methodological framework for rapidly assessing the impacts of climate risk on national-level food security through a vulnerability index. Global Environmental Change 25 (2014) 121–132.

Understanding the links between climate change, food security and nutrition and the adaptation options available will contribute to enhance WFP's programmes to reduce current and future risks to climate change. In the picture, farmers preparing the earth to plant Irish potatoes in Rwanda through WFP's FFA.

The Index used projections of future levels of vulnerability for two time periods: 2050 and 2080. Three climate change scenarios were considered using Intergovernmental Panel on Climate Change (IPCC) scenarios of low emissions (RCP 2.6), medium emissions (RCP 4.5) and high emissions (RCP 8.5).[7] Each scenario was projected using twelve different climate models, and the median result was taken as the value for the respective drought and flood indicators. Scenarios of no adaptation as well as low and high adaptation were taken into consideration, modelled by decreasing the overall sensitivity and adaptive capacity components by 5 to 10 percent and 10 to 15 percent respectively.

Presented in the form of an interactive map, results show how climate change could impact vulnerability to food insecurity in the least developed countries, both in the present day and future, under different adaptation and emission scenarios. The use of the interactive map helps visually highlight to policy makers and the wider public how important it is that large-scale action to both mitigate and adapt will be in our efforts to end hunger by 2030 and beyond. WFP and the Met Office are presently exploring how to apply the index at the subnational level in the East Africa region. The biggest challenge faced is getting data at both more discrete and comparable levels to enable the different climate models to be run.

7. Representative Concentration Pathways (RCPs) are four greenhouse gas concentration (not emissions) trajectories adopted by the IPCC for its fifth Assessment Report (AR5) in 2014.[1] They describe four possible climate futures, all of which are considered possible depending on how much greenhouse gases are emitted in the years to come. Wikipedia, https://en.wikipedia.org/wiki/Representative_Concentration_Pathways.

6. Looking forward

The climate analysis work undertaken under C-ADAPT has been helping WFP and partners get a better understanding of how climate risks and climate change are impacting food security around the world. The lessons learnt along the way are guiding improvements in methodology and application of results. Some of the key actions moving forward include mainstreaming and building capacities in climate analysis methodologies, while also ensuring a greater focus on partnerships, and strengthening linkages of the analyses with policy and programmatic work.

Mainstreaming and building capacities in climate analysis methodologies

Experience to date with undertaking food security climate analyses in different settings has helped WFP and partners develop and refine a number of methodological approaches. Going forward, a focus will be on how to mainstream these methodologies into humanitarian and development settings when climate change is considered a concern for people's food security.

One of the first steps in this direction has been efforts to develop guidance that will build the capacity of a wide range stakeholders to undertake these analyses. Already guidance has been developed on how to undertake CLEAR analyses, as well as getting a snapshot of people's food needs after a disaster with the 72-hour assessment approach. WFP is also exploring how to apply to these analyses to other corporate analysis and assessments tools, including the Three-Pronged Approach and its pillar on Integrated Context Analyses. Country specific assessment tools are also being pursued to measure climate resilience (such as in Bangladesh and Uganda).

Having an array of analytical approaches has nevertheless generated its own challenges in determining which methodological approach to use in a particular context. WFP is currently working on guidance that helps humanitarian and development actors, partners and governments select the most appropriate approach to fit their needs. While there are practical considerations such as data availability and analytical capacities that can make some methodologies more easily applicable in some settings, a key lesson learnt from climate analyses undertaken to date has been that stakeholders should define what questions they want to ask before choosing a method.

A preliminary question to guide this work is to first understand whether the analysis aims to help define policy direction, programmatic interventions or both. Climate projections, for example, tend to be more useful to governments seeking to understand the longer-term impacts of climate change on hunger in their country, and thus persuade policies and financing – including National Adaptation Plans and Nationally Determined Contributions – to consider food security. Alternatively, analyses such as CLEAR can help identify the needs of specific livelihood groups – and consequently interventions that will support their adaptation, such as climate smart agriculture for climate-sensitive farmers. Integrated Context Analyses on the other hand may help in targeting food insecure populations in a particular geographical area with climate adaptation support as part of a complementary package of wider resilience-building support. In the case where a wide variety of questions are being asked, each methodology has demonstrated flexibility to adopt other techniques when needed. For example, rather than doing a lone desk-based climate risk analysis, additional methodologies may be added, including a review of other climate models conducted, along with undertaking community consultations to help extrapolate locally what these projections would mean for people's livelihoods.

Driven by these questions, it has also been obvious that there still gaps that current methodologies have yet to fill. Climate models in particular have difficulty in looking at food security indicators beyond crop production – such as questions of the impact of climate change on food access, market prices and nutrition – often because of the lack of historical data available for socio-economic indicators in humanitarian situations. WFP's work with the Met Office Hadley Centre on the Food Security and Climate Change Vulnerability Index has been an important area of focus in this regard. Downscaling the

Index to the sub-national level is particularly challenging but is being explored as part of a wider partnership with WFP's engagement in the High-End cLimate Impact and eXtremes (HELIX) project. Working with a consortium of partners supported by the European Commission, HELIX is seeking to make adaptation more understandable and manageable for decision-makers by providing a set of credible and coherent views of what the impacts of high levels of global warming will be on the world's bio-physical and socio-economic systems. Lessons from HELIX and the downscaling of the Index may open up a better understanding of how to apply these climate projections into more accessible methodologies such as CLEAR and ICAs.

Gaps in understanding the impacts of climate change on nutrition and possible solutions has also leading WFP to begin to explore how to integrate a climatic lens to its nutrition assessments. Currently this involves examining opportunities with WFP's pilot Fill the Nutrient Gap tool, which was developed by WFP in 2014 to 2015 with technical inputs from UNICEF and research institutes such as the University of California, Davis, the International Food Policy Research Institute and Epicentre. Analysing where diets fall short of meeting nutrient requirements for vulnerable groups, and understanding the contextual factors contributing to these nutrient gaps, can be key in facilitating the identification and choice of strategies for improving nutrient intake for vulnerable groups. WFP is examining whether the tool can help understand the barriers that climate change can pose for vulnerable people's access to adequate nutrition, especially those most vulnerable to malnutrition. It is hoped this work will provide a further avenue to mainstream climate questions into this existing tool.

Enhancing partnerships

Work under C-ADAPT has highlighted the importance of not working in isolation but to rather undertake climate analyses in coordination with a variety of partners. This coordinative and consultative skillset may not always be held by the technical staff carrying out an analysis, requiring leadership at a senior level to facilitate a partnership among different stakeholders. Such leadership is best applied across all the phases of the climate analysis work, from defining its scope, to undertaking the actual analysis, through to validating the results.

In terms of the stakeholders involved, **government partners** are critical to involve from the very outset to ensure the analysis' scope will answer questions that support countries in determining their national policy and programmatic direction. This may mean engaging with a wider range of government departments, outside of normal line ministries, in order to understand their needs within and outside national climate policy processes. For example, beyond ministries of agriculture and social welfare that deal with food security concerns, there may be ministries of finance, environment, meteorology or climate change that should be involved. Working towards a common goal can also facilitate the sharing of data, sometimes guardedly held within government departments, to undertake analyses. Identifying such partners may also identify technical counterparts that can benefit from capacity strengthening in the climate analysis work. Government understanding of socio-cultural issues will also prove to provide valuable insights when validating the results of the analysis. The trust and buy-in of the whole analysis will also help ensure the findings are communicated and used more widely.

Other partners to the analysis process are **humanitarian and development actors**, including international organisations, local non-government organisations and civil society that are focused on addressing concerns related to food security and climate change. Working together helps overcome the disjointedness that can appear in some country settings with a variety of actors working on their own analyses, and thus helping to avoid duplication and potential confusion with different results. A joint focus can instead produce a more comprehensive understanding that benefits programme and policy design, and more effectively addresses government needs. Furthermore, joint analytical work may harness these actors towards designing joint interventions. An example thanks to the C-ADAPT initiative is the partnership that WFP and the International Fund for Agricultural Development (IFAD) have forged. WFP and IFAD are jointly producing climate analyses in a number of countries, helping to efficiently inform programme design with government and other counterparts. At the same time, WFP is helping to enhance the capacity of IFAD's institutional capacities in Earth Observation and Geographic Information Systems to support their agricultural investment work.

Tanzania, Kiteto district. WFP uses, develops and translates climate information to help governments and vulnerable communities build resilience against climate shocks.

Some of these analysis efforts are particularly challenging and outside the technical capacities of the stakeholders involved in the country. In these cases, **technical partners** may need to be employed to lead the actual analytical work to be carried out. Climate modelling in particular requires a skill-set that may be absent at the local level, and thus identification of academic or private sector institutions may prove necessary. During the C-ADAPT initiative, WFP has engaged with a number of partners to facilitate such work, including: the research programme on Climate Change, Agriculture and Food Security (CCAFS) of the Consultative Group on International Agricultural Research (CGIAR); the Intergovernmental Authority on Development (IGAD) Climate Prediction and Applications (ICPAC); the International Research Institute for Climate and Society (IRI) of Columbia University; the Met Office Hadley Centre; and the Overseas Development Institute (ODI). It is important in each case to know the capabilities of the selected institution, and whether they will be able to address the scope of the analysis needs defined in the terms of reference. They may also be able to help contribute to this scoping exercise based on their experience in other settings.

A key lesson from the work on climate analyses is that involving a variety of partners from the beginning of a climate analysis project helps build ownership, capacities and trust, and should generate more positive integration of policies and programmes. To produce these advantages may require a number of "climate champions" in senior roles within different ministries and organisations to help steer the technical aspects of a climate analysis towards these goals, without influencing the overall analysis results. Wherever possible, this higher-level engagement should be encouraged throughout the process, and carried on into the policy and programmatic recommendations.

Strengthening linkages between analysis and programming and policy work

One of the earlier challenges from C-ADAPT's climate analysis work has been ensuring a connection between the outcomes of the analyses and the policies and programmes to be informed by their results. Early work was found to be too dense for policy makers and humanitarian actors to easily interpret, and thus more recent analyses have attempted to generate more accessible recommendations merging from the analysis findings. Focus has also been placed towards producing more concise and visual products (including think pieces and atlases) to avoid the analyses being only used as reference documents. WFP has also explored a variety of innovative ways to share information to a wider audience, including the use of non-traditional communication products, outside of reports, such as interactive maps, infographics and videos.

The methodologies of these food security climate analyses can sometimes still struggle to produce findings that generate decisions on the most suitable programmatic and policy interventions for different vulnerable groups and locations. However these methodologies have also shed light on positive attributes they can bring to the table. For example, analysis of livelihoods has been particularly useful in helping to describe the different types of people affected by climate change and thus identifying possible measures that may address their needs. Community consultations have also been very revealing in better understanding existing adaptation measures, capacities and needs that can address the results from these analyses. Wider stakeholder consultations have also helped to identify technical partners who can provide the know-how for implementing specific types of programmes – either as overall solutions or complementary interventions that will generate longer-term climate resilience benefits.

Partnerships have also shown themselves to be able to building a stronger bridge between the analyses and their application to policy interventions, including supporting governments in incorporating food security concerns into their National Adaptation Plans, Nationally Determined Contributions, and budgetary outlays for climate finance. As previously mentioned, this includes involving a range of non-traditional stakeholders from the outset to ensure they can contribute to the definition of the analysis' scope, and which will in turn better enable the consideration of national policy and programmatic issues. This may also involve coordinating with agencies that are facilitating the UN Country Team's inputs into national policy processes, such as the UN Development Programme (UNDP) or the UN Environment Programme (UNEP).

Such engagement with these different partners can help bridge previously unidentified information gaps between government, humanitarian and development actors on the importance of addressing the climate impacts on food security. These partnerships can also draw out important capacities and expertise across institutions to more effectively define and finance food security programmes that address climate concerns. Given the political nature of some of these issues, high-level "champions" can prove to be important assets in helping stakeholders navigate across institutional mandates so as to focus minds towards the goal of supporting most effectively and efficiently the needs of those most affected by climate change.

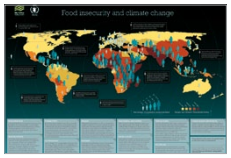
List of Analyses

All food security climate analyses produced by WFP and partners are found at WFP's website: http://www1.wfp.org/climate-and-food-security-analyses.

Global Analyses

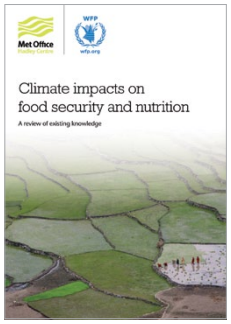
WFP (2015) The Food Insecurity and Climate Change Vulnerability Index and Interactive Map

http://documents.wfp.org/stellent/groups/public/documents/communications/wfp279729.pdf?_ga=2.229353236.908564870.1496058228-908079097.1490783224



WFP (2010) Food Insecurity and Climate Change

http://documents.wfp.org/stellent/groups/public/documents/newsroom/wfp229182.pdf?_ga=2.57512552.395070210.1496058542-908079097.1490783224



WFP (2012) Climate Impacts on Food Security and Nutrition: A Review of Existing Knowledge

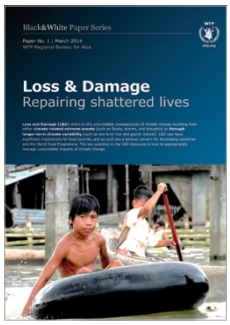
http://documents.wfp.org/stellent/groups/public/documents/communications/wfp258981.pdf?_ga=2.254418760.1353369993.1496058486-908079097.1490783224

Regional analyses

Asia

WFP (2016) Climate impacts on food security and livelihoods in Asia - A review of existing knowledge

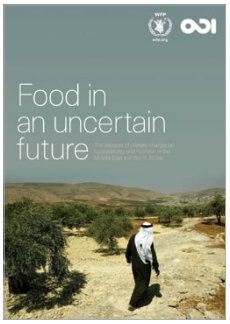
http://documents.wfp.org/stellent/groups/public/documents/newsroom/wfp281745.pdf?_ga=2.142799925.1295369002.1496057959-908079097.1490783224



WFP (2014) Loss & Damage in the Asian Context: Repairing shattered lives

http://documents.wfp.org/stellent/groups/public/documents/newsroom/wfp269945.pdf?_ga=2.230488028.1374046901.1496058177-908079097.1490783224

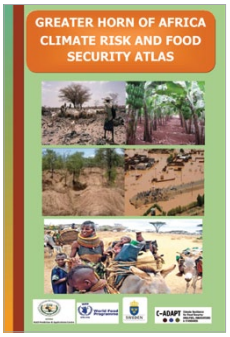
Middle East, North African and Central Asia



WFP (2015) Food in an Uncertain Future: The impacts of climate change on food security and nutrition in the Middle East and North Africa

http://documents.wfp.org/stellent/groups/public/documents/communications/wfp279986.pdf?_ga=2.134208908.309865579.1496058031-908079097.1490783224

East Africa



WFP (2016) The Atlas of Climate Risk and Food Security in the Greater Horn of Africa Region

http://www.icpac.net/wp-content/uploads/Atlas_2017%20May_A3%20REGIONAL.pdf

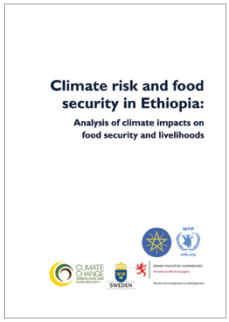
Country analyses

WFP (2016) AFGHANISTAN: Climate Change in Afghanistan: What does it mean for Rural Livelihoods and Food Security?

http://www.wfp.org/sites/default/files/WFP_UNEP_NEPA_Afghanistan_Impacts_climate_%20change.pdf

WFP (2014) CAMBODIA: Consolidated Livelihood Exercise for Analysing Resilience (CLEAR) in Cambodia

http://documents.wfp.org/stellent/groups/public/documents/communications/wfp288374.pdf?_ga=2.8313265.2092994021.1496057977-908079097.1490783224

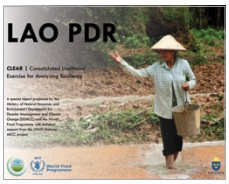


WFP (2014) ETHIOPIA: Climate risk and food security in Ethiopia: Analysis of climate impacts on food security and livelihoods

http://documents.wfp.org/stellent/groups/public/documents/newsroom/wfp269379.pdf?_ga=2.223969053.763672380.1496058116-908079097.1490783224

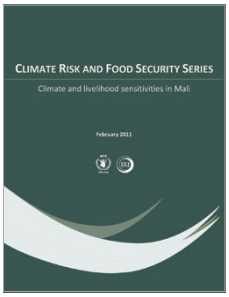
WFP (2014) KYRGYZ REPUBLIC: Climate Risk and Food Security Analysis: An overview of climate trends and the impact on food security Kyrgyz Republic

http://documents.wfp.org/stellent/groups/public/documents/newsroom/wfp269918.pdf?_ga=2.261205576.458520204.1496058058-908079097.1490783224



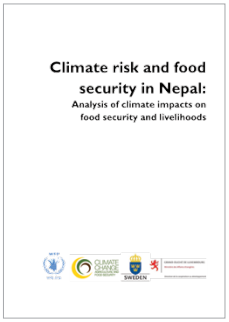
WFP (2016) LAO PDR: Consolidated Livelihood Exercise for Analysing Resilience

http://www.wfp.org/sites/default/files/LAO_CLEAR-%20English%20version-FINAL%201-9-2016-standard.pdf



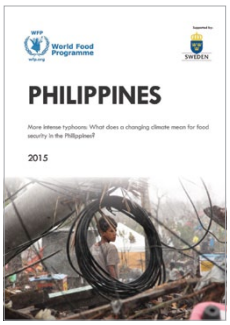
WFP (2011) MALI: Climate and livelihood sensitivities in Mali

http://documents.wfp.org/stellent/groups/public/documents/communications/wfp288373.pdf?_ga=2.211400915.731679245.1496058221-908079097.1490783224



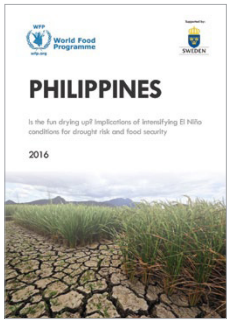
WFP (2013) NEPAL: Climate risk and food security in Nepal: Analysis of climate impacts on food security and livelihoods

http://documents.wfp.org/stellent/groups/public/documents/newsroom/wfp269378.pdf?_ga=2.18312505.1864561584.1496058117-908079097.1490783224



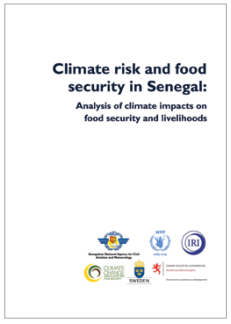
WFP (2015) PHILIPPINES: More intense Typhoons: What does a changing climate mean for food security in the Philippines?

http://documents.wfp.org/stellent/groups/public/documents/ena/wfp277192.pdf?_ga=2.186381353.1011492623.1496057979-908079097.1490783224



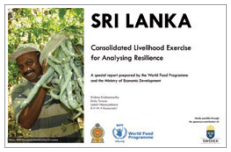
WFP (2016) PHILIPPINES: Is the Fun Drying Up? Implications of Intensifying El Niño Conditions for Drought Risk & Food Security

http://documents.wfp.org/stellent/groups/public/documents/communications/wfp289659.pdf?_ga=2.151187441.956175078.1496057864-908079097.1490783224



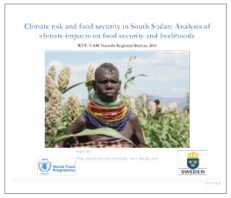
WFP (2013) SENEGAL: Climate risk and food security in Senegal: Analysis of climate impacts on food security and livelihoods

http://documents.wfp.org/stellent/groups/public/documents/newsroom/wfp269381.pdf?_ga=2.143087158.2076133270.1496058147-908079097.1490783224



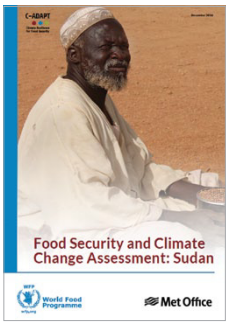
WFP (2014) SRI LANKA: Consolidated Livelihood Exercise for Analysing Resilience (CLEAR)

http://documents.wfp.org/stellent/groups/public/documents/newsroom/wfp269385.pdf?_ga=2.81175255.1568388352.1496058149-908079097.1490783224



WFP (2014) SOUTH SUDAN: Climate risk and food security in South Sudan: Analysis of climate impacts on food security and livelihoods

https://docs.wfp.org/api/documents/WFP-0000013228/download/



WFP (2016) SUDAN: Climate Change and Food Security Assessment in Sudan

http://documents.wfp.org/stellent/groups/public/documents/communications/wfp289238.pdf?_ga=2.192710754.994759488.1496057843-908079097.1490783224

WFP (2015) TAJIKISTAN: Tajikistan Integrated Context Analysis

https://docs.wfp.org/api/documents/WFP-0000015482/download/

WFP (2016) TIMOR LESTE: Consolidated Livelihood Exercise for Analysing Resilience (CLEAR) in Timor-Leste

http://documents.wfp.org/stellent/groups/public/documents/newsroom/wfp282841.pdf?_ga=2.5025075.1668458066.1496057900-908079097.1490783224

Kenya, Koibatek.
WFP's projects reach the most vulnerable people and communities, in places where food insecurity, malnutrition, poverty and disaster risk intersect.

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October 2017

How Climate Drives Hunger: Food Security Climate Analyses, Methodologies & Lessons 2010-2016

C-ADAPT Climate Resilience for Food Security: ANALYSES, INNOVATIONS & STANDARDS

The Climate Adaptation Management and Innovation Initiative (C-ADAPT) is an initiative funded by the Government of Sweden's fast-track climate finance that allows WFP and partners to explore innovative climate-induced food insecurity analyses, programmes and best practices, with the goal to help individuals, communities and governments meet their food and nutrition needs under a changing climate.

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