

Climate Change, Food Security and Disaster Risk Management

Issues paper for the Expert Meeting on
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Summary

This issues paper serves as input to an expert meeting on climate change and disaster risk reduction to be held at FAO, Rome, 28-29 February 2008.

It introduces the state of knowledge on climate change, with particular focus on the implications for food security. It then examines the implications of different conceptual frameworks for food security in the context of a changing climate, before introducing the interlinked fields of adaptation and disaster risk management. The paper briefly highlights financial and institutional architecture to address these challenges. It ends by prompting discussions in the expert group meeting around the policy issues relevant to FAO in achieving food security in a changing climate. These are summarised in the table below.

	Short term	Medium term	Long term
Implementation	<ul style="list-style-type: none"> Disaster risk reduction Social protection Coping-oriented technology Water saving practices Focus on non availability aspects of food security 	<ul style="list-style-type: none"> Agriculture technology for adaptation Water planning and irrigation systems Weather-linked insurance mechanisms 	<ul style="list-style-type: none"> Livelihood diversification Assisted migration Expansion of agriculture into more favourable areas
Research and information	<ul style="list-style-type: none"> Climate change impacts data Food security and biofuels Accessing adaptation finance Building institutional adaptive capacity Assessing user data needs 	<ul style="list-style-type: none"> Efficiency of adaptation measures over time Burden of costs of adaptation Impacts of climate change on rising food prices and security 	<ul style="list-style-type: none"> Areas of more favourable agriculture conditions Financial systems for resource transfer Security and migration issues
Institutions and partnerships	<ul style="list-style-type: none"> Partnerships to work on food security beyond availability Linkages with CGIAR bodies Strengthening national institutional capacity for long term agricultural planning and agricultural extension (broadening scope beyond agriculture to disaster risk management) Links with emergency food bodies including WFP to integrate long term perspectives on chronic food shortages 		<ul style="list-style-type: none"> International architecture for regulating food security Trade, conflict, security, emergency, and migration partnerships

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1. The climate change challenge

What is the evidence for climate change?

In late 2007, the Intergovernmental Panel on Climate Change released their Fourth Assessment Report (AR4), drawing together the scientific evidence on climate change¹. This report states unequivocally the manifold evidence that climate change is occurring. Global average air temperatures are rising, with eleven of the last twelve years (1995-2006) ranking amongst the twelve warmest years in the instrumental record of global surface temperature. The 100-year linear trend (1906-2005) of 0.74°C is larger than the corresponding trend of 0.6°C (1901-2000) given in the Third Assessment Report (TAR), published in 2001. This trend for temperature increase occurs across the globe, and is slightly greater at higher northern latitudes.

Although land surfaces have warmed faster, there is also evidence for rising sea levels consistent with warming of the oceans. Global sea level has risen since 1961 at an average rate of 1.8mm/yr and since 1993 at 3.1mm/yr, with contributions from thermal expansion, melting glaciers and ice caps, and the polar ice sheets. It is, as yet, unclear whether this latter faster rate is due to decadal variation of an increase in the longer-term trend. The effects of climate change on precipitation patterns are more varied, with significant increases in eastern parts of North and South America, northern Europe and northern and central Asia in the period 1900-2005; but decreases in the Sahel, the Mediterranean, southern Africa and parts of southern Asia. Globally, the area affected by drought has likely increased since the 1970s.

Other extreme weather events are also correlated in various ways with climate change. It is very likely over the past 50 years that cold days, cold nights and frosts have become less frequent over most land areas, and hot days and hot nights have become more frequent. It is likely that heat waves have become more frequent over most land areas, and the frequency of heavy precipitation events has increased over most areas. There is also observational evidence of an increase in intense tropical cyclone activity in the North Atlantic since about 1970, although there is no clear trend in the number of cyclones, and little evidence of similar increases elsewhere.

There is more data than ever before to suggest that human activity is responsible for these observed changes in climate. The IPCC AR4 states that there is very high confidence that the net effect of human activities since 1750 has been warming. In contrast, changes in solar irradiance are estimated to have caused a much smaller warming effect (+1.12W/m² compared with +1.6W/m²). Most of the observed increase in globally-averaged temperatures since the mid 20th century is very likely due to the observed increase in anthropogenic greenhouse gas concentrations.

What are the projected future changes in climate?

These observed changes in climate are likely to continue into the future. The IPCC AR4 states that there is high agreement and much evidence that with current climate change 'mitigation' policies and related sustainable development practices, global greenhouse gas emissions will continue to grow over the next few decades. Greenhouse gas emissions at or above current rates would cause further warming and induce other changes in the global climate system during the 21st century that would very likely be larger than those observed in the 20th century. A number of scenarios of socio-economic

development have been developed to help project the range of potential future climate change, depending on different patterns of fossil fuel use. For the next two decades a warming of about 0.2°C is projected for a range of these scenarios, after which potential increases vary with the scenario in question.

As well as outlining the potential degree of warming, the Fourth Assessment Report (AR4) also has higher confidence in the projected patterns of warming, which will be greatest over land and at most high northern latitudes and least over the Southern Ocean and parts of the North Atlantic Ocean. There are very likely to be precipitation increases in high latitudes, compared with likely decreases in most subtropical land regions, continuing trends observed to date. The area under snow cover will continue to contract, leading to increases in thaw depth over most permafrost regions, and decrease in sea ice extent. Furthermore under some SRES scenarios Arctic late-summer sea ice is projected to disappear almost entirely by the latter part of the 21st century.

Changing temperature and precipitation patterns will affect the geographical distribution of extra-tropical storm tracks, leading to a poleward shift and in turn reinforcing changes in wind, temperature and precipitation patterns. There will very likely be an increase in tropical cyclone intensity. The frequency of hot extremes, heat waves and heavy precipitation is also very likely to increase. This altered frequency and intensity of extreme weather events, including droughts, heat waves and floods, together with sea level rise, is expected to have mostly adverse effects on natural and human systems.

IPCC AR4 concluded with high confidence that projected changes in the frequency and severity of extreme climate events will have more serious consequences for food and forestry production, and food insecurity, than will changes in projected means of temperature and precipitation². Since the IPCC Third Assessment Report in 2001, scientific confidence has increased that some weather events and extremes will become more frequent, more widespread and/or more intense during the 21st century; and more is known about the potential effects of such changes. Some of the projected impacts of the most likely changes by sector are outlined in Table 1.

Nevertheless, AR4 also notes that much uncertainty remains of how changes in frequency and severity of extreme climate events with climate change will affect food, fibre, forestry, and fisheries sectors³. Projection of sub-regional impacts of extreme events is highly uncertain, and the complexity of assessing global impacts on food security is enhanced by uncertainty over the future role of agriculture in the global economy. Although most studies available for AR4 assume a rapidly declining role of agriculture in the overall generation of income, no consistent and comprehensive assessment was available.

As a consequence, much work to date has focused on existing vulnerability and exposure. However, based on both modelling projections and understanding of current vulnerability to food insecurity, AR4 concludes that “climate change is likely to further shift the regional focus of food insecurity to sub-Saharan Africa. By 2080, about 75% of all people at risk of hunger are estimated to live in this region”⁴. However, the enhanced vulnerability of this region relative to Asia is noted to be largely independent of climate change and is mostly the result of the projected socioeconomic developments for the different developing regions⁵. This implies that food insecurity in a changing climate *must* tackle non climate-related risks and vulnerabilities.

Table 1: Projected major impacts by sector due to changes in climate and extreme weather events over the 21st century (not taking into account adaptive capacity)⁶

Phenomenon and direction of trend.	Likelihood of future trends based on projections for 21 st century using SRES scenarios	Examples of major projected impacts by sector			
		Agriculture, forestry and ecosystems	Water resources	Human health	Industry, settlement and society
Over most land areas, warmer and fewer cold days and nights, warmer and more frequent hot days and nights.	Virtually certain	Increased yields in colder environments; decreased yields in warmer environments; increased insect outbreaks	Effects on water resources relying on snowmelt; effects on some water supplies	Reduced human mortality from decreased cold exposure	Reduced energy demand for heating; increased demand for cooling; declining air quality in cities; reduced disruption to transport due to snow, ice; effects on winter tourism
Warm spells/heat waves. Frequency increases over most land areas	Very likely	Reduced yields in warmer regions due to heat stress; increased danger of wildfire	Increased water demand; water quality problems, e.g. algal blooms	Increased risk of heat-related mortality, especially for the elderly, chronically sick, very young and socially isolated	Reduction in quality of life for people in warm areas without appropriate housing; impacts on the elderly, very young and poor
Heavy precipitation events. Frequency increases over most areas.	Very likely	Damage to crops; soil erosion, inability to cultivate land due to waterlogging of soils	Adverse effects on quality of surface and groundwater; contamination of water supply; water scarcity may be relieved	Increased risk of deaths, injuries and infectious, respiratory and skin diseases	Disruption of settlements, commerce, transport and societies due to flooding; pressures on urban and rural infrastructures; loss of property
Area affected by drought increases.	Likely	Land degradation; lower yields/crop damage and failure; increased livestock deaths; increased risk of wildfire	More widespread water stress	Increased risk of food and water shortage; increased risk of malnutrition; increased risk of water-and foodborne diseases	Water shortage for settlements, industry and societies; reduced hydropower generation potentials; potential for population migration
Intense tropical cyclone activity increases.	Likely	Damage to crops; Windthrow (uprooting) of trees; damage to coral reefs	Power outages Causing disruption of public water supply	Increased risk of deaths, injuries, water- and foodborne diseases; post-traumatic stress disorders	Disruption by flood and high winds; withdrawal of risk coverage in vulnerable areas by private insurers, potential for population migrations, loss of property
Increased incidence of extreme high sea level (excludes tsunamis).	Likely	Salinisation of irrigation water, estuaries and freshwater systems	Decreased freshwater availability due to saltwater intrusion	Increased risk of deaths and injuries by drowning in floods; migration-related health effects	Costs of coastal protection versus costs of land-use relocation; potential for movement of populations and infrastructure; also see tropical cyclones above

2. Conceptual frameworks for climate change, disasters and food security

Climate change will have profound implications for food security across the globe, but these implications are far from clear and the causal pathways from changes in climate to changes in food security outcomes are complex and likely to vary from region to region. The examination of food security needs to consider the broader range of sectors and activities contributing to food production, including agriculture, fisheries and forests. It also requires increasing attention to urban and peri-urban areas rather than only a rural focus, as these areas become increasingly important areas for markets, storage and production as well as consumption.

This section introduces three ways of analysing these linkages and pathways. No single conceptual framework is advocated, since each has its strengths and limitations, but they do share one feature that advances the analysis beyond conventional climate change modelling: they consider other impacts apart from the availability of food.

2.1. Food security analysis

The standard definition of food security used by the Food and Agriculture Organisation is a “situation that 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”⁷. Food security analysis under these terms tends to have been based on a systems or livelihoods perspective and encompasses four main elements of food security – the availability, stability, utilisation and access to food. Climate change is likely to impact on all four of these elements, not just on availability.

Availability of food

The most direct impact of climate change on food security is through changes in food production. Short term variations are likely to be influenced by extreme weather events that disrupt production cycles. These more geographically heterogeneous impacts are difficult to predict with accuracy and have a bearing on the stability aspect of food security outlined below. Most assessments of the impacts of climate change deal with aggregate changes (gains and losses) in arable land, changes in actual and potential yields, and inter-annual variability of harvests. Climate change is projected to lead to 5-170 million additional people being at risk of hunger by 2080⁸, with this large range explained by the variations in different model outputs. The UK Hadley Centre’s HadCM2 and HadCM3 models, for example, suggest that climate change will lead to increased crop yields at high and mid latitudes, but decreased yields at low latitudes⁹. While initially the global food system may be able to accommodate such changes – because falling production in some regions could be offset by rising production elsewhere – these models estimate that about 80 million people will be at risk of hunger by the 2080s due to climate change impacts. Most of these food insecure people will be located in arid regions and the sub-humid tropics, particularly Africa, which is projected to suffer reductions in yields and decreases in production under both models. Later work by the same team refines these projections by running the models under various ‘SRES’ emissions scenarios and projected socio-economic scenarios¹⁰, thus adding greater

complexity to the analysis, but at the same time increasing the range of potential outcomes in terms of food insecure people.

These models all agree that climate change impacts on the availability of food will vary geographically. Temperate regions in the high latitudes will see a slight increase in productivity due to extended growing seasons and expansion of area suitable for crops. Higher carbon dioxide concentrations may also have a positive influence on many crops, especially C3 crops such as wheat, rice and soybean; although conversely C4 crops such as maize and sorghum will experience fewer positive effects. The popularity of these C4 food crops in southern Africa, in conjunction with the climate projections, contributes to a significant decrease in food availability. A recent meta-analysis of climate risks for crops in 12 food insecure regions based on statistical crop models and climate projections for 2030 from 20 global climate models shows that South Asia and southern Africa will suffer negative impacts on food crops that are important to food insecure populations, particularly if sufficient adaptation measures are not adopted¹¹.

One global simulation model concluded that the total amount of land available for cereals cultivation is likely to increase by some 9% by 2080, with the biggest gainers being the Russian Federation (+64%), Central Asia (+53%), North America (+41%) and northern Europe (+16%) (see Table 2).¹² However, most of Africa – especially Southern Africa and North Africa, but also West Africa and East Africa – is projected to lose much of its current farmland, with highly damaging consequences for food security in the world’s most food insecure continent. Projected losses of cereal production potential in sub-Saharan Africa range from 33% by 2060 to 12% by 2080.¹³ Certain countries will be hit more than others: a disaggregated analysis of African agriculture concludes that three countries – Chad, Niger and Zambia – will lose “practically their entire farming sector” by the year 2100¹⁴.

Table 2. Projected impact of climate change on suitable land for cereals

Region	Reference	Relative to reference			
	1961–1990 (1,000 ha)	1990	2020	2050	2080
North America	358,202	102	110	121	141
Eastern Europe	124,935	103	101	96	96
Northern Europe	45,462	101	109	113	116
Southern Europe	38,524	98	94	94	91
Western Europe	63,267	100	98	98	97
Russian Federation	243,898	105	124	148	164
Central America & Caribbean	51,505	99	105	109	99
South America	653,060	102	104	105	102
Oceania & Polynesia	115,310	102	102	102	88
Eastern Africa	316,282	99	98	100	96
Middle Africa	254,500	102	104	106	102
Northern Africa	11,782	106	97	62	25
Southern Africa	31,316	88	55	48	54
Western Africa	178,095	99	101	100	96
Western Asia	23,561	105	112	94	101
Southeast Asia	97,831	100	98	103	104
South Asia	189,132	101	101	99	97
East Asia & Japan	149,694	102	99	108	110
Central Asia	12,908	111	117	147	153
Developed	993,529	102	110	119	128
Developing	1,965,735	101	101	103	100
World	2,959,264	101	104	108	109

Source: Fischer *et al.* 2002:64; regions projected to lose farmland are highlighted

A key challenge for food security policy in highly affected countries – especially in Africa, where agriculture remains the dominant economic sector – is to determine whether (and for how long) to continue investing in agriculture as the main livelihood activity and source of food for the majority of the population, and when to switch the policy focus to diversification and facilitating viable exits from agriculture for those farmers whose livelihoods are directly compromised by these processes.

Stability

Although much scientific attention has been paid to the availability of food through modelling, relatively less is known about the stability of food supplies and its effect on food security. The stability element of food security refers to adequacy of food supplies “at all times” and to the potential for losing access to the resources needed to consume adequate food, since even a temporary disruption to food supplies or access can have fatal consequences. This may occur, for example, through failing to insure against income shocks or lacking the reserves to compensate for such shocks.

Weather extremes and climate variability are the main drivers of food production instability, especially in rain-fed farming systems with limited irrigation. There remains little analysis of the impact of the changing frequency of extreme weather events on stability, particularly the interaction on the local level between relatively moderate impacts of climate change on overall agroecological conditions and much more severe climatic and economic vulnerability¹⁵. Already many areas, such as southern Africa, are accustomed to unpredictable and unstable harvests based on inter-annual climate variability, but even for these places the pace and projected levels of warming may expand, and rising frequency and intensity of extreme events such as droughts is likely to increase the instability of food production. Several models forecast not just higher average temperatures and lower rainfall in semi-arid regions, but increasing probability of El Niño Southern Oscillation (ENSO) events, which have become “more frequent, persistent and intense since the mid-1970s”¹⁶. Other locations with formerly stable and predictable weather conditions may become subject to variability, contributing to emerging potential for food crises.

Utilisation

The third element of food security refers to the utilisation of food. Climate change will alter the conditions for food safety and use. Changing temperature and precipitation patterns will alter the ranges of vector, water- and food-borne diseases, such as cholera and diarrhoea. Projected increases in risk of flooding of human settlements, especially in coastal areas from both sea level rise and increased heavy precipitation, is likely to result in an increase in the number of people exposed to vector-borne (e.g., malaria) and water-borne (e.g., cholera) diseases. This in turn lowers their capacity to utilise food effectively, as when people are ill they are unable to use food effectively, thus compromising their status of food security.

Populations in water-scarce regions are likely to face decreased water availability, particularly in the sub-tropics, with implications for food processing and consumption¹⁷. Changing climatic conditions also affect safe and storage. Increasing temperature, for

example, could increase the likelihood of food poisoning, especially in temperate regions. Although there has been much research on the health impacts of climate change, as with stability of food, this element of food security remains understudied to date.

Access

Arguably as important as the availability of food is access to food by all members of the population. This means that market conditions and considerations like political stability and the presence of civil strife are also important in determining access to food. It also serves to explain the seeming paradox between self-sufficiency and food security: while Hong Kong and Singapore, for example, are far from self-sufficient because their food production is constrained by limited land; they are food secure at both national and household levels because their populations derive access to food through other sources. Other countries (such as South Africa and the United States) are food secure at national level, but have members of their population suffering food insecurity due to poverty and failures of markets and social welfare systems.

At the global level, lower food prices and rising incomes have led to improvements in food security, despite rapidly rising populations, as more and more people are able to access affordable food. Climate change, however, poses a threat to this positive trend, as regional and aggregate shifts in food production and availability will affect markets and commodity prices. Indeed, currently ‘soaring’ food prices suggests that this process might already have started. When food becomes scarce, due to a variety of factors including the impacts of weather related extreme events such as a drought or flood, or because of gradual processes of falling per capita food production, prices will rise. This affects both national economic performance (e.g. through impacts on agricultural exports) and household-level food security¹⁸.

Access to and the development of markets for food, especially in remote rural areas, therefore remains a crucial response to enable greater food security in the face of climate shocks and stresses. Access to food is also likely to be influenced by complex secondary impacts of climate change including conflict, human insecurity and migration. As with stability and utilisation, exploring the access element of food security under alternative climate change scenarios has been underrepresented in the academic literature to date. This is reflected in the poor level of citable literature in the AR4 report of the IPCC in 2007, which, while noting these lacunae, focuses on changes in food availability through modelling of gradual long term climatic changes.

2.2. Entitlement analysis

The ‘entitlement approach’ was developed by Amartya Sen, whose work on famines showed that rather than being caused by drought or flood and consequent crop failure, most famine mortality results from the inability of people to acquire food through either purchase or exchange, or transfers¹⁹. The entitlement approach is useful for our purposes because it draws analytical attention to other sources of food apart from production, and highlights the need for more empirical research and modelling on the likely effects of climate change on other components of local and national food systems. The distribution and reproduction of entitlements to food is determined by the livelihood system in the local economy, as well as structural factors in the local political

economy that construct ‘social vulnerability’ (e.g. gender)²⁰. In Sen’s terminology, famine – or food insecurity – results from ‘entitlement failure’, which could occur in one or more of four domains: production, labour, trade or transfers.

Production-based entitlement

The projected impacts of climate change at the aggregate (global and regional) level have been discussed. The entitlement approach operates best at the micro-level of households or livelihood groups (e.g. farmers, landless labourers), often in combination with a livelihoods framework. An entitlements-based analysis of climate change would take account of differences in dependence on food production by different groups of households. For instance, farmers are most directly vulnerable to ‘failure of production-based entitlement’ due to climate change, because they depend most heavily on crop production for both their food and their income. Poor farmers with undiversified livelihoods and few asset buffers are most vulnerable of all, because they lack alternative sources of food when their harvests fail.

Labour-based entitlement

When crop production is inadequate, farmers look for work to supplement their food and income, and the rural non-farm economy becomes an important determinant of household food security, through its capacity to generate ‘labour-based entitlement’ to food. Apart from farmers, other groups that depend indirectly on agriculture for their living are also vulnerable to a collapse of demand for their services – such as landless labourers. (Sen labelled this effect ‘derived destitution’.) One plausible consequence of climate change is that pressure on rural labour markets will increase, and if the supply of labour rises while demand for labour is constant or falling, real wages will fall, exacerbating food insecurity in poor rural communities. Another ‘second round’ consequence of climate change could be an increase in labour migration out of areas where food production is more variable and employment opportunities are falling, with unpredictable implications for household food security that require detailed context-specific analysis and modelling.

Trade-based entitlement

‘Trade-based entitlement’ describes the ability to convert income or assets into food through purchase or exchange. In rural areas, farmers and pastoralists already face falling terms of trade during climate-triggered food crises when they convert their assets (such as livestock) into food – excess supplies of assets on local markets drives asset prices down, while excess demand for food pushes food prices up, until the poor are priced out of the market for food and face starvation. Urban residents and others who do not grow their own food are likely to feel the effects of climate change indirectly, through rising prices in places where food availability is falling or more unstable. To some extent, the relative affluence and political influence of urban consumers, plus increasingly interconnected global markets, might insulate urban residents against negative shocks and processes affecting food production even within their own country: food can always be imported. It is notable that even during major famines, cities are rarely affected. Here again, the entitlement approach highlights the importance of an analysis disaggregated both geographically (within as well as between countries) and by livelihood system.

Transfer-based entitlement

The final legal source of food is ‘transfer-based entitlement’, which describes all gifts or donations (including food aid) from others. Informal transfers are provided by extended families and communities (‘informal social security systems’, patronage networks, the ‘moral economy’), but are vulnerable to covariate shocks. If climate change undermines agricultural production in a farming community, the capacity of local residents to support each other will be compromised and the scale of informal transfers can be expected to contract. Formal transfers are provided by governments and donors, and range from humanitarian relief during emergencies to institutionalised social welfare systems that deliver regular cash transfers to ‘vulnerable groups’ (such as pensioners). A ‘best bet’ prediction is that climate change will place increased demands on the international relief system to fill domestic food gaps with emergency food aid, as well as increasing the caseload of chronically food insecure people who need longer term social assistance, in the form of regular food aid or cash-based safety nets. Given the likelihood that food production will be undermined most in countries that are already poor and food insecure, this scenario implies a declining capacity of governments in the worst affected countries to deliver food security for their citizens, and an increasing role for the international community in underwriting food security in these countries.

The application of entitlements analysis for climate change to date have central in balancing conceptions of biophysical vulnerability with attention to the social determinants of people’s vulnerability to changes in climate conditions, particularly extreme events and natural disasters²¹. In doing so, it has helped shift the debate on disaster risk reduction and climate change adaptation away from solutions based only on technology or factors directly related to climate and towards a more comprehensive approach to tackling climate change and development.

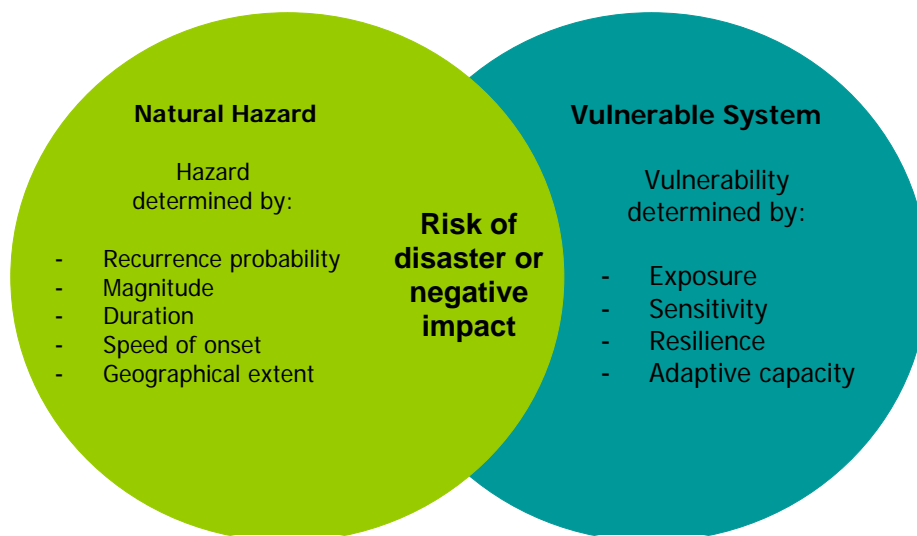
2.3. Vulnerability analysis and assessment

Reducing vulnerability provides another possible framework and focus of activity. It is already becoming a unifying framework for the climate change adaptation and disaster risk management communities in a development context, and underpins a toolkit for targeting and assessment. Vulnerability analysis moves beyond equating vulnerability with exposure to a hazard, towards examining how vulnerability is determined by a wide range of social factors affecting sensitivity to shocks and stresses and ability to bounce back and adapt over time (Figure 1). It is therefore a prerequisite to the trend to move away from disaster response to disaster preparedness. Reducing vulnerability therefore requires an understanding of the dynamic play of multiple driving forces.

Vulnerability remains a highly debated concept, with origins in natural hazards, poverty and food security literature. Application to climate change impact assessments and disaster risk reduction has come more recently. A variety of definitions have been proposed²², but a recent definition from the adaptation community usefully captures vulnerability as *the state of susceptibility to harm from exposure to stresses associated with environmental and social change and from the absence of capacity to adapt*²³.

Vulnerability can be defined as:
*The state of susceptibility to harm from exposure to stresses associated with environmental and social change and from the absence of capacity to adapt*²⁴.

Figure 1: Vulnerability: Moderating the risk of negative impacts from natural hazards²⁵



A meta-analysis of vulnerability definitions reveals a distinction in the literature between different epistemological approaches²⁶. The natural hazards school of thought focuses on the objective study of a given hazard, emphasizing the exposure of an ecosystem to the hazard. This might be termed biophysical vulnerability. In contrast, the human ecology and political economy schools of thought emphasise a particular group or social unit of exposure, and especially to the social, economic and political institutions that render them vulnerable or not. This might be termed social vulnerability.

The change in conceptual thinking over time has been reflected in changing methodologies of vulnerability assessment²⁷. Biophysical vulnerability is based on a more static, linear relationship between hazard and impact, and vulnerability refers to the sensitivity of natural environments to projected changes in climate²⁸. Many such biophysically focused vulnerability assessments have been carried out for climate change impacts on different ecosystems and sectors on a case study basis, including coasts²⁹, rivers/water resources³⁰, forests³¹, wetlands³², and agricultural productivity³³.

The focus on biophysical vulnerability has been critiqued by social scientists because it assumes that humans are passive recipients of impacts, and thus fails to capture their dynamic ability to mediate such hazards, either through resisting an event or coping once it occurs³⁴. A focus on social vulnerability addresses this by recognizing that exposure to physical phenomena is embedded in, and mediated by, the particular human context (social, economic, political, institutional) in which they occur. Whilst physical phenomena are necessary for the production of a natural hazard, their translation into risk and potential for disaster is therefore contingent upon human exposure and a lack of capacity to cope with the negative impacts that such exposure might bring to individuals or human systems³⁵.

Understanding the impacts of climate change is thus inextricably linked with the human conditions that create a resilience or vulnerability to that event³⁶. Vulnerability analysis helps move food security and climate change debates beyond food production alone. This understanding also highlights a shift in focus from which places are vulnerable, towards a focus on who is vulnerable and where they are located. Vulnerability is differentiated on the basis of age, ethnicity, class, religion and gender (see box 1)³⁷.

Box 1: Gender and vulnerability

Socio-cultural constructions of gender roles can affect the vulnerability of women and men differentially, as well as their capacity to adapt to climate change. Much research has documented the greater vulnerability of women to livelihood shocks, including climate-related hazards, reflecting their subordinate positions within largely patriarchal societies³⁸. Women in low-income countries are heavily involved in climate-sensitive activities such as agriculture³⁹. This means that climate change impacts will affect women directly and disproportionately through changes in agriculture productivity, water, vegetation and fuelwood availability and changes in the health environment, since women bear the brunt of household care.

Women's vulnerability and lack of adaptive capacity is also exacerbated by their insecurity of property rights⁴⁰. Formal land and water rights for example are heavily gendered, with implications both for vulnerability and for capacity to adapt productive livelihoods to a changing climate. Increasing pressure on resources may disrupt informal systems that have operated to overcome gender inequality in property rights⁴¹.

Evidence from disasters such as hurricane Mitch in 1998⁴² and the Asian tsunami of 2004⁴³ reveals how certain groups are more vulnerable to extreme events. Home-based children and the elderly are more likely to be injured or killed by extreme hazards event. Women are at increased risk of domestic violence and sexual abuse, and often assume a disproportionate amount of the burden during rehabilitation periods, due to temporary housing structures and camps, their pivotal roles in the reproductive sphere⁴⁴, and likelihood of having economic activities based in or around the home⁴⁵.

There have been calls for greater recognition of gender rather than focusing exclusively on the vulnerability of women. This widens analysis to include men's vulnerabilities, gender aspects of mitigation and helps emphasise women's adaptive capacity⁴⁶. Emerging evidence on how gender identity and subjectivity are reconstructed during post-disaster recovery⁴⁷ highlights the need to further develop vulnerability studies to incorporate more nuanced understandings of the role of gender.

Tools and methods for vulnerability assessment

The different conceptions of vulnerability (biophysical and social) have led to a variety of tools and methods used in assessing the status of vulnerability within the climate change and disasters fields. Typically within biophysical vulnerability attempts have tended to focus on the top-down modeling of global impacts (sometimes by sector, eg water, health etc); whilst proponents of social vulnerability tend to take a more bottom-up approach focused around place-based case studies. On a global scale, comparative indicators facilitate a systematic assessment of the nature of vulnerability⁴⁸, whilst on a local scale place-based approaches are still popular. As it is methodologically impossible to apply theoretical frameworks across scales of analysis, due to the scale specificity of the manifestations of vulnerability (even if driving forces are similar)⁴⁹, indicators and place-based approaches remain two of the most popular tools.

Indicators are quantifiable constructs that provide information either on matters of wider significance than that which is actually measured, or on a process or trend that otherwise might not be apparent⁵⁰. As well as being used in their own right, indicators

can be aggregated to form indices, allowing incorporation of a wider range of parameters. Indicators and indices are thus useful for encapsulating a complex reality in simple terms and permitting comparisons across space and/or time. However, they can necessarily only provide a snapshot in time, and thus are limited in their ability to represent dynamic processes of vulnerability. In order to address these limitations, all indicators of vulnerability should be seen as in a constant process of refinement.

There have been multiple attempts at developing national level indicators and indices for human aspects of vulnerability, each varying in the nature of vulnerability addressed, the hazard involved, and the geographical region. This is particularly well developed for small island developing states, while a national level index has been created to assess cross-country variation in social vulnerability to climate change in Africa⁵¹. Others have taken more global approaches to assessing vulnerability and resilience explicitly for climate change⁵². Complex analyses incorporating multiple stressors have been carried out at the local level in various locations⁵³. Indicators are also commonly used at national and regional scale to assess environmental variability and hotspots for food insecurity⁵⁴. These indices all vary in their approach (especially between data-driven/inductive as opposed to theory-driven/deductive) and methodological choices such as means of standardization and transformation⁵⁵.

Humanitarian and relief communities also have well developed tools to measure, both quantitatively and qualitatively, the impact of disasters on food security and livelihoods. These include food security systems including famine early warning systems (such as the USAID Famine Early Warning System – FEWS NET), and food insecurity and vulnerability information and mapping information systems (such as the IAWG-FIVIMS and Global Information and Early Warning Service).

As an alternative approach to social vulnerability, other studies have tended to prefer smaller-scale and more context-specific methods of assessment. Working at the local scale enables more comprehensive analyses of both the biophysical and social vulnerability to hazards. Many place-based studies of vulnerability have been carried out at the small scale across the world. In southern Africa, for example, most countries have a National Vulnerability Assessment Committee (NVAC), and there is a Regional Vulnerability Assessment Committee (RVAC), which assess vulnerability to food insecurity taking into account a variety of stressors, including climate-related phenomena such as drought.

The sustainable livelihoods framework can be used for assessing local level vulnerability and adaptive capacity through analysis of the status of five “capital assets” – financial, human, social, physical and natural⁵⁶. The sustainable livelihoods framework arose as a holistic tool that promotes multi-dimensional understanding of the nature and dynamics of livelihood vulnerability. Livelihoods in this context refer not only to income but also the social institutions, gender relations and property rights necessary to support a standard of living⁵⁷. Rather than assessing poverty as a static variable, by looking at the assets and how individuals gain access to them to make a living, the sustainable livelihoods framework is therefore able to give a much more dynamic representation of local realities, adding some depth to questions about why people find themselves impoverished. In doing so, the livelihoods framework has much in common with entitlements analysis outlined in the previous section⁵⁸.

3. Disasters and adaptation

3.1 Disaster risk management and adaptation

The IPCC Fourth Assessment Report (AR4)⁵⁹ highlights that, even with mitigation policies and measures, the legacy of anthropogenic greenhouse gas emissions commits us to climate change in the future. The human impacts of climate change are not evenly distributed. AR4 and the Stern Review on the economics of climate change identify poorer developing countries as being especially vulnerable to climate change because of their geographic exposure, low incomes and greater reliance on climate sensitive sectors, particularly agriculture. This in turn poses multiple threats to economic growth, poverty reduction, food security, and the achievement of the Millennium Development Goals in developing countries⁶⁰.

In the face of these challenges, a growing body of theory and practice has developed around adaptation to prepare for and respond to climate change. Although there are multiple definitions, adaptation can be characterised as *‘the ability to respond and adjust to actual or potential impacts of changing climate conditions in ways that moderate harm or take advantage of any positive opportunities that the climate may afford’*⁶¹. Put simply:

Adaptation is about reducing the risks posed by climate change to people’s lives and livelihoods⁶².

Adaptation shares much in common with disaster risk management in preventing harmful impacts from extreme events. One of the manifestations of climate change is a projected increase in the frequency and intensity of extreme weather events, which without reductions in vulnerability will increase the risk of disaster events. Climate change adds additional challenges to existing historic weather-related shocks, including more severe drought impacts, heat-waves, and accelerated glacier retreat, hurricane intensity, and sea level rise. The International Federation of the Red Cross and Red Crescent Societies notes that there has been an increase in the number of events, and a geometric increase in the number of people affected by hazards since the beginning of records in the 1960s⁶³.

The Centre for Research on the Epidemiology of Disasters defines a disaster as: a situation or event which overwhelms local capacity, necessitating a request to national or international level for external assistance, an unforeseen and often sudden event that causes great damage, destruction and human suffering⁶⁴.

Based on this definition, an event of similar magnitude in one place may translate into a disaster, but in another may not, depending on the capacity of the population to cope. An often lower capacity to cope in developing countries means that they tend to suffer disproportionate effects of disasters. With drought, for example, whilst only 11% of the people exposed to this hazard are in the developing world, they account for 53% of people who lose their lives⁶⁵. In addition to the direct economic, physical and human impacts of disasters, there are also often a number of indirect effects, which may long outlast the duration of the hazard itself. Many countries in central America, for example, are still suffering the consequences of hurricanes, such as hurricane Mitch in 1998.

Despite some direct links between climate change and disasters – continued sea level rise, for example, will increase the area exposed to the risk of coastal flooding – the link is generally non-linear. Individual events cannot be attributed specifically to climate change, as they may simply form part of natural variation in climate. However, the increased frequency and intensity of weather-related events is representative of a projected trend, so links are often drawn with climate change. The European heatwave of 2003, repeated inland flooding in central Europe in the early 21st century, and the busy Atlantic hurricane seasons of 2004 and 2005 have all highlighted these links⁶⁶.

Adaptation has clear linkages to practices of disaster risk management designed to tackle such extreme weather events. In the context of climate change, disaster risk management refers to the systematic processes to lessen the impacts of climate-related natural hazards. This comprises all forms of activities, including structural and non-structural measures to avoid (prevention) or to limit (mitigation and preparedness) adverse effects of hazards⁶⁷. This has more recently been set within the broad context of sustainable development under the framework of disaster risk reduction (DRR), also known as disaster reduction (Box 2).

Box 2: Fields of action in the disaster risk reduction framework⁶⁸

- Risk awareness and assessment including hazard analysis and vulnerability/capacity analysis;
- Knowledge development including education, training, research and information;
- Public commitment and institutional frameworks, including organisational, policy, legislation and community action;
- Application of measures including environmental management, land-use and urban planning, protection of critical facilities, application of science and technology, partnership and networking, and financial instruments;
- Early warning systems including forecasting, dissemination of warnings, preparedness measures and reaction capacities.

3.2 Linking adaptation and disasters communities

Although hazard links may be non-linear, there are clear inter-relationships between tackling climate change and disasters. Effective disaster risk management cannot take place without consideration of climate change, and climate change adaptation will need to highlight the likelihood of increased disasters. In reality, however, two distinct communities of researchers and practitioners have evolved, one dealing with climate change and the other dealing with hazards/extremes/disasters.

This divergence has been attributed to (and in turn reinforced by) differing timescales and spatial scales of activity by the two communities⁶⁹. The climate change community tends to focus on the longer term, making projections that last well into the 21st century and dealing mainly with a change in variability, whilst the disasters communities has typically been focused on the short term. Climate change science also works primarily at the global level, with models reflecting the global nature of the atmospheric and oceanic circulation; whilst those working in the disaster field have tended to focus more on the local and national level where weather extremes are manifest, perhaps overlooking the root causes of vulnerability at the international level. The consequences of these different foci have led to the development of different language and terminology used to refer similar concepts and phenomena, and cemented the divide.

There have been multiple calls for greater integration between the two communities⁷⁰, and as both knowledge of climate change and the negative effects of disasters increase, there are signs that the two communities are beginning to come together. This is at least in part due to the realisation across both groups that they are failing to reduce the vulnerability of people to climate change and disasters⁷¹. Rather than trying to predict the future occurrences of climate change and hazards, therefore, reducing the risk from climate change and disasters provides a more fail-safe policy for protecting livelihoods and food security in the face of potential unknown hazards. A greater focus on vulnerability reduction through climate risk management is therefore emerging as a unifying concept between climate change and disaster risk management, and is beginning to bridge the gap⁷².

3.3 Climate risk management and adaptation for food security

Adaptation will be critical to reduce the projections of food insecure people under climate change, and also to ensure that the first Millennium Development Goal, on halving hunger by 2015, is met⁷³. With regards to production, changing patterns of extreme events are likely to have more significant impacts than gradual temperature or rainfall changes. Changes to drought frequency are particularly important given their potential to dramatically reduce yields and livestock, especially in rainfed systems. Climate-related impacts also have the potential to affect other aspects of food security, particularly through adverse impacts on infrastructure, transport and food distribution systems and their infrastructure. Negative impacts may also disrupt markets by reducing consumer purchasing power.

Commercial agriculture, for example, has a typical lag time of 15-30 years to implement changes in the production system; whereas an individual subsistence farmer growing an annual crop will have much more flexibility in changing what they grow year-on-year – although of course this is constrained by access to resources (inputs such as seed and fertiliser, and physical capital such as land and tools). One common adaptation for commercial farming is the use of crop and flood insurance, although there is a risk that such options actually increase susceptibility by providing a cushioning layer which prevents farmers from taking decisions to link their farming activities with the weather conditions⁷⁴.

Perhaps more important, and accessible to farmers at all levels, is the provision of climate information and early warning, so that they are able to make decisions that are appropriate to the upcoming conditions. Seasonal forecasts are commonly produced by national meteorological services, which model a range of climate parameters and provide probabilistic short term forecasts of the likelihood of rainfall being less than the average, average, or higher than average over the coming season. At the national level this information is clearly important to predict shortfalls in yields and to plan for potential food security crises. The increasing availability of climate information after the 1991/2 drought in southern Africa assisted in preparing for subsequent El Niño-Southern Oscillation events, reducing negative impacts⁷⁵.

However, food insecurity is often more likely to be manifest at the sub-national level and so providing this information to individual farmers is important⁷⁶. Simulated experiments with small-scale rural subsistence farmers have shown that they are able to

effectively use such information to adapt their farming methods and mitigate the adverse effects of drought⁷⁷. But several studies have highlighted the importance of the process of transferring information from national to local level, which must be timely and take into account the farmers preferences in information channels and timing⁷⁸

3.4 Financing mechanisms for adaptation

Adaptation remains much less developed than greenhouse gas mitigation as a policy response⁷⁹, and there are no binding commitments on adaptation within the UN Framework Convention on Climate Change. That said, article 4.1 of the convention states that parties should “protect the climate system for the benefit of present and future generations, on the basis of equity and in accordance with their common but differentiated responsibilities and respective capabilities”. With regards to adaptation in particular, article 4.3 states that developed countries should meet the agreed incremental costs of adaptation in full; and article 4.4 commits developed countries to assisting developing country parties that are particularly vulnerable to the adverse effects of climate change in meeting the costs of adaptation⁸⁰.

Considerable financial assistance will be required to meet needs for adaptation, with estimates of annual adaptation costs in developing countries estimated by various sources at between US\$28-86 billion⁸¹. Providing such resources is likely to require an innovative mix of public and private finance, channelled through conventional development assistance routes, international financial structures, and the private sector.

Throughout the course of negotiations on the UNFCCC and the Kyoto Protocol three major funds have been established for adaptation activities: the special climate change fund and least developed countries fund (under the UNFCCC), and the adaptation fund (under the Kyoto Protocol) (see table 3). Two of these funds are managed and administered by the Global Environment Facility, who have also been funding adaptation since 2004 under their Strategic Priority Areas. The OECD also provides assistance through its Disaster Assistance Committee, although this is only on an ad hoc basis, typically when donations have been received in the aftermath of hazards⁸².

Table 3: Summary of the three adaptation funds under the UNFCCC and Kyoto Protocol⁸³

Source	Fund name	Main intended applications
UNFCCC	Special Climate Change Fund	- to assist developing countries in diversifying their economies - preparing initial national communications - strengthening climate networks and the provision of information/capacity building/disaster preparedness
	Least Developed Countries Fund	- preparing and implementing National Adaptation Plans of Action (NAPAs) on urgent and immediate adaptation needs in least developed countries
Kyoto Protocol	Adaptation Fund	- to finance concrete adaptation projects in developing countries that are party to the Kyoto Protocol

Over the medium to longer term there is greater potential to adapt to climate change through mainstreaming adaptation and risk in core development activities, relative to financing of adaptation through the climate regime⁸⁴. If the risks of climate change are not considered when planning development projects and programmes, there is a chance that the effects of climate change may negate the positive effects of the initiatives.

A number of donors, both bilateral and multilateral, have taken this onboard and now consider “climate proofing” or climate risk assessment of their development projects to ensure that such projects do not inadvertently increase vulnerability to climate change and extreme weather events. Such a risk management approach to integrating adaptation to climate variability and change is gaining momentum across a range of donors including the UK, Norway⁸⁵, Germany⁸⁶; and multilateral donors are the World Bank⁸⁷. The OECD is currently building on previous efforts to prepare broad guidelines on how to screen development portfolios to assess potential for mainstreaming adaptation into development activities⁸⁸.

3.5 Institutions for adaptation and disaster risk reduction

Vulnerability reduction and mainstreaming adaptation and risk into development activities are thus important policy goals for responding to climate change and disaster risk. But implementing these changes often requires fairly radical shifts in thinking and new institutional architecture⁸⁹. Typically with extreme weather events the focus, particularly in developing countries, is on the recovery from a disaster rather than vulnerability reduction before the event, and this system is reinforced by the investment policies of donors⁹⁰. This system is beginning to change with integrated disaster risk management and the acceptance that the timeframe of focus for risk reduction needs to consider pre-event vulnerability reduction, as post-event response. For this to occur, different institutions need to be involved at various stages⁹¹.

At the national level, many countries are having to modify their disaster management institutions to reflect this new paradigm, or design disaster management policies and setting up institutions to formalize and implement such policies. In the USA disaster response has typically been coordinated by the Federal Emergency Management Association (FEMA), which was integrated into the Department of Homeland Security in 2001. Still, the institutional arrangements have been criticized⁹². Gopalakrishnan and Okada outline 8 characteristics that they believe are necessary for institutions implementing disaster risk management to have: awareness/access, autonomy (in that the institution must have the authority to act in the case of a disaster/state of emergency being declared), affordability, accountability, adaptability (to take into account cultural norms as well as the nature of the risk), efficiency (how well they do all of the above), equity and sustainability.

Whilst the reorientation of existing disaster management frameworks can be problematic, even countries introducing disaster management policies and institutions from scratch can come up against barriers. The information available with regard to climate change and disasters is increasing through vulnerability and risk assessments, and having this information has been shown to be correlated with the number of lives saved and general quality of response after a disaster⁹³. Information sharing is

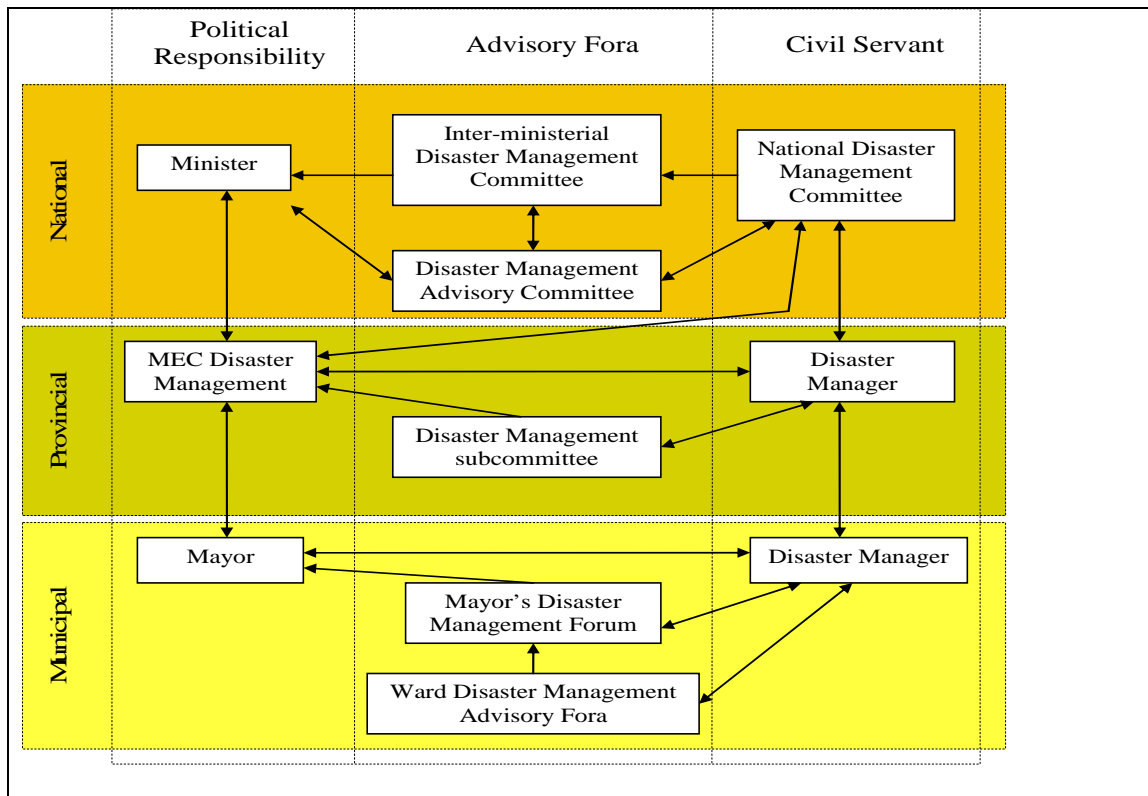
dependent on understanding of the importance of that information, knowing to whom to disseminate it, and how. Individuals act as key hubs within a network, and thus play a large gate-keeping role.

The multisectoral nature of climate change and disasters means that effective implementation can only be achieved when disaster management institutions are integrated with other relevant government institutions at all levels of administration within a country, and for this to occur, it often means that people are charged with disaster management responsibilities even if it is not their core area of competency or focus of work. A study comparing disaster management in Italy and the USA showed that very few public servants working in the field of disaster management had a background in the topic and this, together with the norms of professional culture, forms a key control over how information is disseminated, shared and used⁹⁴.

As well as including administrative structures, it is also important to create institutional frameworks that allow for participation of other relevant stakeholders. NGOs, for example, have a long history of providing emergency humanitarian assistance after disasters, and longer term reconstruction. They are arguably suited, and indeed often have a comparable advantage in this role, due to their location on the ground and understanding of local context and conditions. Although they may have a tendency to compete with each other for “worldview” space, reflecting their different ideologies and sympathies, there is plentiful evidence of effective NGO coordination in response to disaster such as the Asian tsunami⁹⁵ and Mozambique floods, where over 49 countries and 30 international NGOs provided assistance which then had to be coordinated on the ground⁹⁶.

Box 3: Case study disaster management - South Africa

South Africa has actively embraced the change in paradigm from disaster response to longer term integrated disaster risk management. The recent introduction of legislation and a new policy framework now means that, at least on paper, South Africa has one of the most advanced institutional frameworks for disaster management in the world⁹⁷. The process of policy formation began in the late 1990s, with legislation being promulgated in 2002 – the Disaster Management Act no 57 of 2002⁹⁸. This came into force in 2003, and since then has progressively been introduced at the different levels of political administration (provincial, district municipality and municipality), ending with municipality in 2004. Whilst political responsibility is assumed by existing figures, in order to implement the new legislation and policies, a new institutional structure had to be created. Advisory fora are multi-stakeholder institutions in an attempt to improve integration between disaster management and other policy arenas, whilst a number of civil servant positions with explicit responsibility for disaster management have been created.



4. Food security in a changing climate: Issues for FAO consideration

The implications of climate change and a potentially increasing disaster burden provide FAO with the challenge of determining what assistance it can provide to member states to maintain and improve food security under changing climatic conditions, and how it can link with other institutions to promote vulnerability reduction/disaster risk reduction. These issues will be drawn out in greater depth at the expert meeting. In order to stimulate discussion, some of the potential options for FAO engagement on food security, adaptation and disasters are outlined below, highlighting measures that might be taken to address issues relevant to the short, medium and long term. This refers to the timescale over which the issue is likely to assume greater importance rather than representing a prioritisation for FAO action. A summary (Table 4) follows short descriptions of the suggested issues.

4.1 Short term issues

In the short term, the ongoing occurrence of frequent disaster events demonstrates the need for redoubled efforts to protect agricultural production against extreme weather events and climate variability. There is already evidence that climate variability and extremes are increasing in many areas, pushing the capacities of existing agricultural and food systems. To understand how these issues of environmental change interact with other economic/market and political driving forces to affect food security suggests the use of a livelihoods lens, as already being advocated by the Household Food Security, Nutrition and Livelihoods section of the Nutrition and Consumer Protection Division.

Measures to address enhanced climate variability include improvements to disaster risk reduction and seasonal forecasting to enable more effective climate risk management⁹⁹. Coping with climate shocks and stresses also entail greater attention to the emerging range of social protection measures related to agricultural production. These include weather-based crop insurance, asset restocking, starter packs and seed fairs, and cash transfers¹⁰⁰. Changing environmental conditions are already necessitating greater transfers of agricultural practices and technologies.

Research and information will need to be enhanced to prepare for climate change impacts on crops and agricultural systems. This analysis may include the impact of the growing demand for biofuel crops. Research into the specific impacts of climate change on productivity is already being provided by several units within FAO: for example the Fisheries and Aquaculture Economics and Policy Division (FIE), Fisheries and Aquaculture Department is looking at the impact on fisheries, and the Plant Production and Protection Division, Agriculture and Consumer Protection Department is investigating the impacts on seed security. Additionally, the new Climate Change and Bioenergy Unit in the Environment Climate Change and Bioenergy Division is developing a climate impact assessment tool for crop production. FAO also has a long history of involvement in agricultural risk management (through the Policy Assistance Division of the Technical Cooperation Department), primarily from an asset/market/production perspective (credit risk) – but there is scope to include climate change and disaster risk management as causes of production and asset risk, which can in turn be communicated to farmers.

Improved understanding of user needs for climate and vulnerability information will be central to strengthening capacity of food security systems to adapt to change. As international financial and technical flows for adaptation grow, there is a requirement to strengthen capacity of agriculture sector institutions to access these resources. The Global Information and Early Warning Service, Trade and Markets Division of the Economic and Social Development Department in FAO, for example, are already modelling crop prospects and pests and could include climate early warning information into its assessments. The Climate Change and Bioenergy Division is also drawing together information on evidence for local level adaptation, which will assist in highlighting where further information is needed at the grassroots level.

The rising burden of extreme events and climate change will require FAO to enhance their partnerships with international and national institutions working on broader aspects affecting vulnerability and food security outside food availability alone. National and international research links to put transfers and emerging technologies into practice will need to be combined with strengthening of national institutional capacity for long term agricultural planning and agricultural extension. Finally, with the potential for acute food shortages to become chronic deficits, agricultural analysis to improve the integration of long term perspectives within emergency food bodies such as WFP.

4.2 Medium term issues

Greater attention will be required in the medium term to the gradual shifts and new hazards associated with climate change. Water planning and increased irrigation is likely to be required for areas that currently depend on rain-fed agriculture if long term

viability of agriculture is to be ensured, coupled with development and dissemination of crop varieties and practices suited to changing climatic conditions.

Existing social protection may be challenged by changing frequency and magnitudes of hazards and more widespread insurance mechanisms may be required to cope with shocks and stresses to agricultural systems. There is presently little understanding of the effectiveness and efficiency of adaptive measures, including social protection over time with projected climate changes. Equally, there is limited understanding of the actual and potential impact of climate change on world food prices, linked to both climate shocks and to the evolving markets for both biofuels and biomass for carbon sequestration.

4.3 Long term issues

In the longer-term, as the configuration of arable land availability changes, both globally and within countries, it might be appropriate and necessary to think in terms of facilitating the movement of people out of areas that are in agro-ecological decline, to areas with higher (ideally rising) agricultural potential. In very large countries like China, India and Brazil, this population movement might be manageable within national borders: farmers would move from one province or state to another. At the global level, if it is true that countries like Chad, Niger and Zambia will lose large proportions of their farmland during this century, then the challenge is to generate alternative livelihoods that are not climate-sensitive for millions of farmers, within the next 2-3 generations at the latest – which implies pursuing a very different development strategy to investing in agriculture, including investing heavily in education of rural populations. Most livelihoods that are not climate-sensitive require a literate and well-educated workforce.

The challenge of finding alternative livelihoods to smallholder farming in agriculture-based societies has been successfully negotiated across the world – in Europe over a century ago, more recently in the ‘Asian tiger’ economies, and is currently occurring in India and Bangladesh. In much of Africa the problem of how to achieve a structural transformation of the economy away from small farm agriculture seems intractable, but is rapidly becoming a strategic imperative, driven by erratic weather and the specific threat that climate change poses to food production in Africa.

A more radical scenario would envisage large-scale international migration of small farmers from adversely affected countries (say, Chad or highland Ethiopia) to newly available arable lands (say, in Siberia or northern Canada). While this option might seem highly unlikely right now, evolving population dynamics (high-income countries with low population growth might lack the workforce to farm all their newly available arable land) and rising global food insecurity (putting intolerable demands on the international humanitarian system) could make it more feasible in decades to come. The potential for such issues to arise makes it imperative to strengthen institutional links with existing partners, such as FAO; but also to forge new partnerships with other relevant international organisations, such as the UNHCR and IOM.

Table 4: Summary of suggested issues for FAO consideration

	Short term	Medium term	Long term
Implementation	<p>Disaster risk reduction measures</p> <p>Social protection targeting climate shocks</p> <p>Agriculture technology to improve coping</p> <p>Water saving and irrigation systems to cope with increased climate variability</p> <p>Enhance focus on non availability aspects of food security</p>	<p>Agriculture technology for adaptation, including development / dissemination of new crop varieties / practices</p> <p>Water planning and irrigation practices</p> <p>Widespread weather-linked insurance mechanisms</p>	<p>Livelihood diversification out of more climate sensitive activities, including farming</p> <p>Assisted migration schemes</p> <p>Facilitating expansion of agriculture into more favourable areas</p>
Research and information	<p>Climate change impacts data on crops and systems</p> <p>Linking food security and biofuel production</p> <p>Strengthening capacity of agriculture sector institutions to access available adaptation financial flows</p> <p>Building adaptive capacity of agriculture systems to cope with long term change</p> <p>Assessing user needs for climate vulnerability data</p>	<p>Effectiveness and economic efficiency of adaptive measures, including social protection, over time</p> <p>Burden of costs of adaptation</p> <p>Impacts of climate change on rising food prices</p>	<p>Analysis and preparedness for areas of more favourable agriculture conditions</p> <p>Financial Systems for resource transfer</p> <p>Possible entrenchment of chronic food deficits – consequent supply issues, security issues and migratory flows</p>
Institutions and partnerships	<p>Partnerships to work on aspects of vulnerability to food security beyond availability</p> <p>Linkages with CGIAR bodies on agriculture practices and technology</p> <p>Strengthening national institutional capacity for long term agricultural planning and agricultural extension (including links to disaster infrastructure)</p> <p>Links with emergency food bodies including WFP to integrate long term perspectives on chronic food shortages</p>		<p>Potential international architecture for regulating food security for entrenched chronic food deficits</p> <p>Conflict, security, emergency, and migration partnerships (IOM, UNHCR, WFP)</p> <p>Links to trade bodies</p>

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