KNOWLEDGE FOR ADAPTATION SERIES: 5

Hunger and Climate Change

An analysis of key variables in southern Africa

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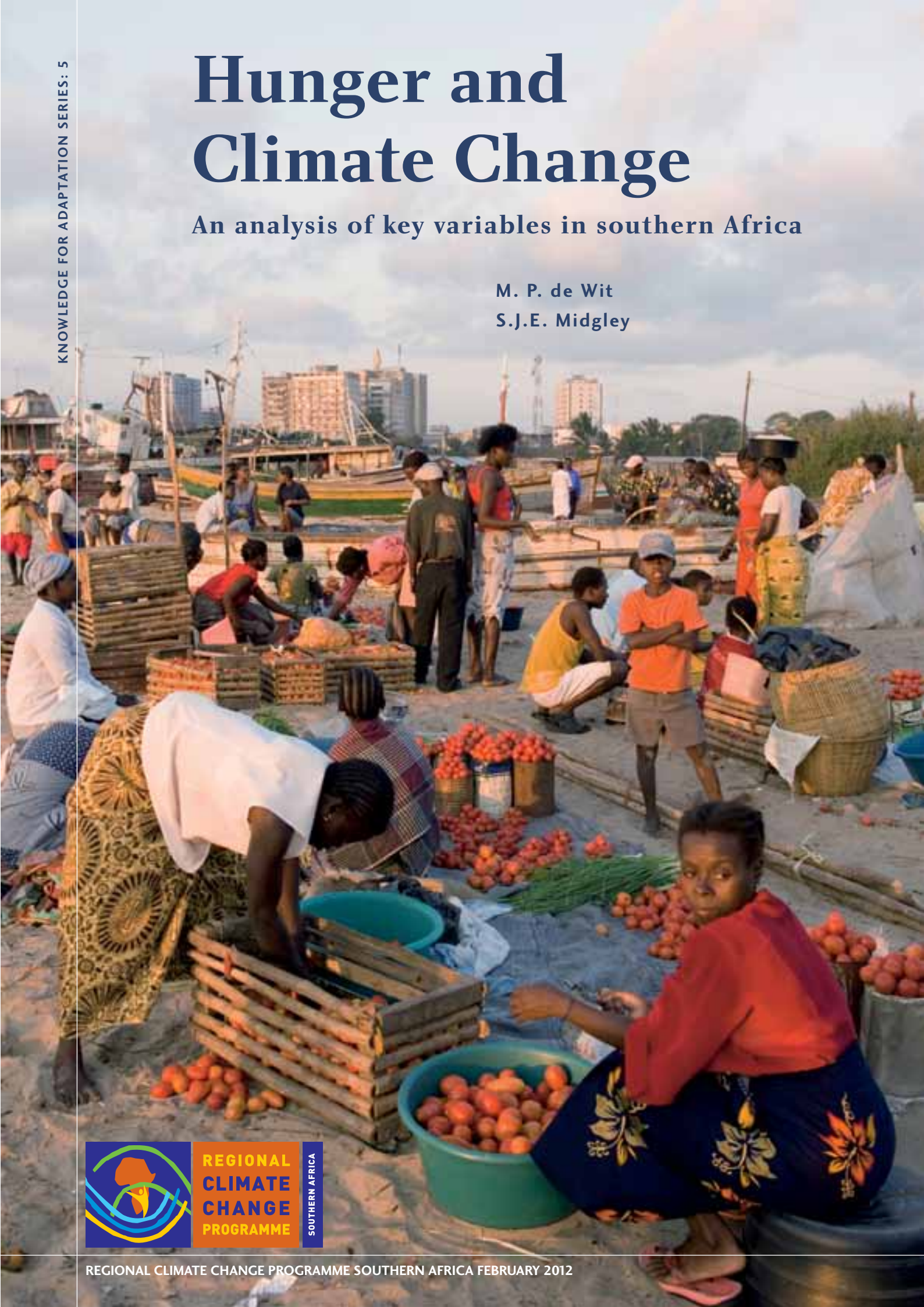

REGIONAL CLIMATE CHANGE PROGRAMME SOUTHERN AFRICA

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REGIONAL CLIMATE CHANGE PROGRAMME

The Regional Climate Change Programme Southern Africa (RCCP)

The RCCP aims to contribute to the achievement of southern Africa's climate change adaptation needs, socioeconomic development and poverty alleviation objectives, including the Millennium Development Goals.

By synthesising the relevant climate change science, developing strategic research and strengthening science-policy-governance-finance dialogue, the RCCP will build an evidence base for appropriate transboundary responses, strengthen the region's voice on international platforms and negotiations, and enhance its ability to equitably access the necessary finance for effective climate change adaptation.

The five-year Regional Climate Change Programme of work (2009–2014) with Southern African Development Community (SADC) partners on the impact of climate change, aims to increase regional participation in globally funded adaptation projects and improving resilience. The RCCP has four outputs, the first of which focuses on the scientific basis for understanding climate change impacts in southern Africa.

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Key messages

Undernourishment is a large-scale problem in southern Africa – about 95 million people (40%) are undernourished (2004–2006).

Undernourishment is one indicator of food insecurity and exists when individual caloric intake is below the minimum dietary energy requirement. Across the Southern African Development Community (SADC), the rate of increase in undernourishment has slowed down substantially from very high levels in the early 1990s. However, progress differs widely between countries. Socioeconomic issues, including poverty, environmental stressors and conflict, underlie the problem. Food shortages are determined not only by local production failures, but also failure to access food at household level.

Efforts to reduce undernourishment must be contextualised within current and future risks to food systems associated with climate change and climate shocks.

Food production in the region is already significantly affected by high climatic unpredictability, shifts in rainfall patterns, droughts and floods. It is expected that with continuing climate change the region will suffer an overall decline in agricultural production, with particular risks to maize and wheat production. Increasing climate variability and risk of extreme climate events is likely to further destabilise yields from year to year.

A trend analysis for SADC for 1990–2006 identified the most important relationships between undernourishment and food system indicators.

Undernourishment is related mostly to insufficient carbohydrate (although proportionally too high) and protein intake related to a lack of own production on a national level. Overall, there was a weak association between undernourishment and imports, exports, food aid, international food prices and national per person income. Declining undernourishment is relatively strongly associated with increasing fruit and cassava consumption. National per person food production has stagnated, with most countries experiencing a decline in food production since the early nineties (with some exceptions). On the other hand, food imports per person (mainly cereals) have risen, in some countries substantially, while smaller and arid countries have a high dependence on imports to feed their populations. Only two countries were consistent net exporters of food since the early 1990s. The value of SADC food exports and imports, both from and to the rest of the world and within SADC has increased rapidly; importantly, imports increased more rapidly than exports, and net exports turned negative in 2002 and have rapidly declined since then. The terms of trade in food (the value of exports divided by the value of imports) declined by on average 2% per year from 2000–2006. Following a strong decline in food aid from the early 1990s, aid has again increased in the early 2000s.

With persistent high levels of undernourishment, stagnant production and consumption, increasing dependence on imports and declining terms of trade, SADC countries have become increasingly vulnerable to shocks that may disrupt food supplies or diminish the ability to increase food consumption.

Such shocks can take many forms such as a decline in employment and income, volatile market prices, communication and transport breakdowns and delays, droughts, floods, conflicts and war, and many others. The impacts of climate variability and climate change on production are already affecting the region's food system, a situation which is expected to become even more challenging in the future. Any response to undernourishment also needs to include a strong focus on the weak integration of food markets and erratic local prices. The current barriers to regional trade, lack of physical infrastructure, institutional failures, and distorting legislation and policies are hindering the region's ability to provide food to those in need, when they need it and at reasonable prices. The region faces many challenges to its current agricultural and trade policies and strategies relating to production of and access to food, improving nutrition, and liberalising trade within SADC (regional trade agreements). These have as yet not achieved notable success in terms of reducing undernourishment. Although liberalisation in trade policy has progressed substantially, inconsistent policies with the SADC free trade protocol related to export and import licenses, as well as temporary import bans on agricultural commodities, are still evident. An improvement in regional trade remains a preferred response option to absorb shocks in the food system.

Greater resilience of food production systems could be achieved through locally suitable, tested and affordable technologies supported by strong extension.

These could include high temperature and drought resistant crops, strengthening of livestock production, and promoting irrigation where suitable. An indirect response strategy is to diversify away from a largely subsistence agricultural economy, reduce a country's dependence on agriculture, and increase wealth. This in turn will provide rising incomes that improves the ability to adapt at a household level. Farmers can further be supported through education and extension, improved access to climate forecasting, on-farm research on climate adaptation technologies, opening access to credit, and prioritising market development and access.

The key determinants of food security for households do not lie primarily in improved crop yields – economic and socio-political factors play a larger structural role in undermining households' coping abilities.

The vulnerability of the farming sector and households to climate change will vary. Some regions or households have a larger adaptive capacity than others. Such regions or households may face greater exposure to climate stress, but better access to resources and infrastructure will strengthen their ability to cope and adapt. Reliable information on climate variability and climate change is needed. More accurate estimates of where and when crops are produced and their yield are a sure way to reduce price volatility and resulting hardship caused by price spikes. Addressing the underlying, systemic causes of food insecurity in southern Africa will go a long way towards absorbing climate-related shocks.

Regional Economic Communities are taking steps towards developing institutions and policy frameworks to support agricultural development in the face of climate change, but this requires further political commitment, investment, research, and institutional strengthening.

Importantly, climate change impacts are not expected to be homogeneous across the region but will emerge as transboundary hotspots, intensifying the need for investments which facilitate improved food trade between production surplus and deficit regions. Regional dialogue which brings together role players and decision makers, for example the platforms provided by FANRPAN and CAADP, can play an increasingly important role in informing national and regional policy development.

In spite of overall progress, undernourishment remains a serious problem in southern Africa. A villager and his child await monthly food rations distributed by the World Food Programme, Tsholotsho, Zimbabwe.

1. Introduction

1.1 Background and problem

The report focuses first on the problem of undernourishment in southern Africa, and then provides a broader discussion around food security. It must be noted that 'undernourishment' and 'food security' are two distinct terms. Undernourishment refers to an absolute minimum standard of caloric (energy) intake, while food security is a broader term which includes adequate access to food.

Definitions of food security and undernourishment

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 (UN World Food Summit, 1996). Household food security is the application of this concept to the family level, with individuals within households as the focus of concern.

Undernourishment exists when caloric intake is below the minimum dietary energy requirement (MDER). The MDER is the amount of energy needed for light activity and a minimum acceptable weight for attained height, and it varies by country and from year to year depending on the gender and age structure of the population (FAO/WFP, 2009).

The FAO has developed the concept of four dimensions of food security (FAO, 2008):

- Food availability: The supply of sufficient quantities of food as determined by production, stock levels and net trade, including food aid.
- Food access: An adequate supply of food does not guarantee access by household members, which also depends on incomes and expenditures (cash), market dynamics and food prices.
- Food utilisation: This captures the importance of factors such as adequate dietary diversity, care and feeding practices, clean water, sanitation and access to health care, which contribute to a state of nutritional well-being by determining how well the body can utilise the nutrients in the food.
- Stability: Food security incorporates a time related dimension, since household or individuals must have access to adequate food *at all times*. This could be put at risk by sudden shocks (political, economic or climatic crises) or cyclical events (e.g. seasonal food insecurity at the end of the dry season).

Table 1: Number of undernourished people in SADC, 1990–2006
Numbers in brackets indicate percentage of population undernourished.

Country/region	Undernourished 1990–1992, mil	Undernourished 1995–1997, mil	Undernourished 2000–2002 mil	Undernourished 2004–2006, mil
TOTAL SADC (excl. RSA)	51.1	74.4	85.8	94.3 (48)
DRC	11.4 (29)	26.5 (57)	36.6 (70)	43.9 (75)
Tanzania	7.4 (28)	12.1 (40)	12.5 (36)	13.6 (35)
Mozambique	8.2 (59)	8.6 (52)	7.9 (42)	7.5 (37)
Angola	7.2 (66)	7.3 (58)	7.4 (52)	7.1 (44)
Madagascar	3.9 (32)	5.4 (37)	6.1 (37)	6.6 (35)
Zambia	3.3 (40)	3.9 (41)	4.8 (45)	5.2 (45)
Zimbabwe	4.3 (40)	5.5 (46)	5.5 (43)	5.1 (39)
Malawi	4.3 (45)	3.7 (36)	3.5 (29)	3.8 (29)
Botswana	0.3 (20)	0.4 (24)	0.5 (27)	0.5 (26)
Namibia	0.4 (29)	0.5 (29)	0.4 (21)	0.4 (19)
Lesotho	0.2 (15)	0.2 (13)	0.3 (14)	0.3 (15)
Swaziland	0.1 (12)	0.2 (20)	0.2 (17)	0.2 (18)
Mauritius	0.1 (7)	0.1 (6)	0.1 (5)	0.1 (6)

Note: SADC countries are Angola, Botswana, Democratic Republic of Congo (DRC), Lesotho, Madagascar, Malawi, Mauritius, Mozambique, Namibia, South Africa, Swaziland, Tanzania, Zambia, Zimbabwe. Seychelles will reapply for SADC membership in 2011. South Africa is mostly excluded from the analysis as the country has comparatively low levels of undernourishment (as defined by the FAO) and will skew the analysis.
Source: FAO Statistics (http://faostat.fao.org)

For food security objectives to be met, all four dimensions must be fulfilled simultaneously.

Chronic hunger (here used synonymously with undernourishment), remains one of sub-Saharan Africa's (SSA) most pressing problems, and the sub-continent has been described as "the world's most food-insecure region" (FAO/WFP, 2009). The Southern African Development Community (SADC) accounts for approximately a third of the SSA population, but 44% of SSA's undernourished people. Over the period 2004–2006, approximately 94 million people in SADC were undernourished (Table 1). During that period, almost 44 million undernourished people were in the Democratic Republic of Congo (DRC) alone. Tanzania, Mozambique, Angola, Madagascar, Angola, Zambia, Zimbabwe and Malawi all have sizeable undernourished populations as well. Despite some notable improvements in certain countries, the number of undernourished people, as defined by the FAO, is rising.

In relation to population size, an average of almost half (48%) of all the people living in SADC were undernourished in the time period 2004–2006 (Table 1). The figures are heavily influenced by the fact that three-quarters of the population of the DRC are undernourished. More than 40% of the Zambian and Angolan populations are also undernourished, followed by Zimbabwe, Mozambique, Tanzania and Madagascar with more than a third of their populations undernourished.

Efforts to reduce hunger globally are contained in the first of the Millennium Development Goals (MDGs) which were agreed by the United Nations at the Millennium Summit in 2000. MDG1 aims to "eradicate extreme poverty and hunger" by 2015, and specifically "halve, between 1990 and 2015, the proportion of people who suffer from hunger" in each country. Across southern Africa, progress towards the achievement of the eight MDGs by the target date has been mixed (United Nations and World Bank online databases; United Nations, 2010) and shown to be sensitive to global and regional shocks. Although progress has been made in most southern African countries in reducing hunger, it is generally not sufficient to achieve the targets set for 2015.

The problem is further complicated by projected severe impacts of global climate change in southern Africa (Gregory *et al.*, 2005; Boko *et al.*, 2007) within the context of already highly vulnerable households (Ziervogel and Calder, 2003) and the HIV/AIDS epidemic (Drimie and Gillespie, 2010). Agriculture remains the dominant economic sector in many countries and about 70% of the population depends on farming (mostly rainfed) for their livelihood. Across the region the impacts of warming, shifting rainfall patterns and growing seasons, and more frequent and intense climatic extremes such as droughts and floods, are already increasing yield variability, leading to food shortages and reduced income.

Climate change will increasingly play a pivotal role in food security (Easterling *et al.*, 2007; FAO, 2010). Increasing strain on agricultural growth is likely, thus rendering poverty and hunger reduction targets elusive as population numbers rise (Chapman *et al.*, 2011). When crop and livestock production fail because of drought, floods, pests or diseases, both poverty and hunger take hold. Of particular concern is the expectation that the African staple crop maize, which is central to large food-insecure populations, is at significant risk under climate change (Lobell *et al.*, 2008). Given the high vulnerabilities already in the system, climate change threatens the socioeconomic and political stability and advancement of the region. This observation provides an immediate rationale for improving our understanding of the food system of southern Africa.

Although much has been published on undernourishment and food insecurity in recent years (see, for example, FAO/WFP, 2009; Jayne *et al.*, 2009; Haggblade *et al.*, 2008; Dorosh *et al.*, 2007; Misselhorn, 2005), no analysis of the food system and undernourishment in the southern African region as a whole has been conducted. A regional food system analysis is needed to help inform policy-makers where to focus their efforts in addressing undernourishment, particularly against the background of the need to strengthen climate resilience. It cannot be assumed that intervention is needed on nutrition, production systems, socioeconomic wellbeing, trade or any other aspect of a food system before analysing, to some extent, where the main relationships are. This study attempts to contribute to the literature on undernourishment in southern Africa by analysing the food system as a whole, overlaying the projected impacts of climate change, and suggesting a way forward.

1.2 Objective

The primary objective of this study is to provide better insights into the relative importance of those variables that relate to undernourishment in the southern African food system. The secondary objective is to overlay (on the current situation) the projected patterns and impacts of increasing climate variability, and longer-term climate change on the regional food system and undernourishment. Potential response options are then formulated broadly.

The study is one of a series of Knowledge for Adaptation titles published by the RCCP. This series is targeted at SADC decision and policy makers and aims to support their leadership in securing government commitments in the climate change, health and development contexts – including from influential institutions and other key stakeholders in the food security arena.

2. Method and approach

This study differs from earlier published literature in this field in that it has a high-level focus on a regional food system in the fourteen SADC countries specifically. It is also motivated out of concern that a partial approach to drivers of undernourishment can easily lead to a policy focus on one or more aspects of a food system (such as production, nutrition, prices, trade or income), while possibly relatively more important components are overlooked in formulating policy interventions regionally and nationally. Such oversights would be even more costly and represent missed opportunity for building resilience, when the potential impacts of climate change are taken into account.

This report focuses on historical data from 1990 onwards to provide a comprehensive picture of longer-term drivers and trends of undernourishment in southern Africa. The analysis is based on data from the FAO (as published on their website) unless stated otherwise. The FAO data was not available in an annual time series format and we had to rely on averages for a set of years (1990–1992; 1995–1997, 2003–2005 and 2004–2006). It is recognised that measurements of undernourishment have been previously criticised and large estimation errors are possible (Gabbert and Weikard, 2001). The reliance of the FAO on the national, aggregate nature of data on food availability and distribution have also been criticised and suggestions have been made to also focus attention on household survey data (Smith, 1998). It is furthermore recognised that undernourishment is much more complex than just a measurement of calories consumed. Several other indicators of food insecurity and nutrition, focused on the most vulnerable groups such as children, may also be helpful to further inform a strategy to address hunger.

We have relied on national level FAO data due to its wide use in several leading publications (FAO/WFP, 2009) and since we are mainly concerned with higher-level systems, including trend analysis. The focus is on identifying larger food system trends in sub-Saharan Africa, which may need to be complemented with more detailed work on the more salient features of the food system at a later stage.

We used several food system indicators such as consumption, own production, imports, exports, food aid and the relative size of the agricultural sector for each country over the time periods for which data was available from the FAO. We further calculated covariances, a linear measure of dependence, by dividing the standard deviation by the average. Large covariances indicate interdependencies in the datasets and in such cases results need to be interpreted with more caution. Correlation measures were generated with a Macintosh Numbers spreadsheet package.

To answer the question on how sensitive undernourishment is to changing prices we calculated the 'price elasticity of undernourishment' or the percentage change in the number of undernourished people divided by the percentage change in international food prices. Not only prices but also income affects consumption. We therefore also calculated the 'income elasticity of undernourishment' or the percentage change in the number of undernourished people divided by the percentage change in local income, as an indicator on how sensitive undernourishment is to changing incomes.

A food systems approach includes all stages from the origins of food to the plate. It includes growing, harvesting, packaging, transporting, marketing, consumption and disposal of food. Food systems are further influenced by a particular context, such as changing climates, political upheaval or socioeconomic stress. Food systems typologies usually include aspects of food security, food availability, access to food and utilisation (Ericksen, 2008). Undernourishment can thus be caused by any variable throughout the food system (whether production, trade, infrastructure, markets, etc.) or by the context wherein it operates, including factors such as household feeding practices.

The analysis of why undernourishment occurs in southern Africa is based on ordinary least squares (OLS) theory, a standard linear regression procedure. We used a simple statistical correlation technique, pairing undernourishment to the variables listed in Section 3.1 (i.e. indicators on the food system). The results are expressed as a correlation coefficient, ranging from -1.0 to +1.0. Guidelines for the interpretation of correlation coefficients are somewhat arbitrary. The following general rules of thumb are used:

- large negative correlation (-1.0 to -0.5)
- large positive correlation (0.5 to 1.0)
- medium negative correlation (-0.5 to -0.3)
- medium positive correlation (0.3 to 0.5)
- small negative correlation (-0.3 to -0.1)
- small positive correlation (0.1 to 0.3)

Correlations do not say anything about cause. It cannot, therefore, be concluded from a correlation analysis that one factor causes the other. It is just a statement on how strong variables are related and is taken as a starting point – those variables that are more strongly related to undernourishment are also relatively more important in developing a strategy against undernourishment, subject to the test that their covariances are relatively small.

3. Results

3.1 Main trends in food system indicators

3.1.1 Undernourishment: characterising the trends

Although the absolute number of undernourished people increased between the periods 1990–1992 and 2004–2006, the rate at which the number of undernourished people changed decreased substantially (analysis based on Table 1, figures not shown). For the whole region, the rate of increase in undernourished people slowed down from 46% between the time periods 1990–1992 and 1995–1997, to 10% between the time periods 2000–2002 and 2004–2006. In spite of overall progress, undernourishment remains a serious problem in southern Africa.

In absolute terms dietary energy consumption is lowest in the DRC, Angola and Zambia, and only Mauritius and South Africa are comfortably above the minimum level per capita. Nevertheless, dietary energy consumption has increased most in Mozambique and Angola, followed by Malawi and Namibia (data not shown).

In the short term, four groups of countries can be distinguished based on progress on undernourishment (Table 2). In the longer term, the DRC remains the country with the most serious problem with both high percentages of the population affected and an increase in undernourishment over this time period. It is noticeable that countries with large undernourished populations are either making good progress (Angola, Mozambique, Zimbabwe) or are making very poor or poor progress (DRC, Tanzania, Madagascar, Zambia). No progress was made in countries where the number of malnourished is relatively low, possibly suggesting a lack of easy additional gains.

Table 2: Short- and long-term progress of SADC countries in terms of undernourished populations.

	Very poor progress	Poor progress	No progress	Good progress
Shorter term (2004–2006 versus 2000–2002)	DRC	Tanzania Zambia Malawi Madagascar	Botswana Namibia Swaziland Lesotho Mauritius	Angola Zimbabwe Mozambique
Longer term (2004–2006 versus 1990–1992)	DRC Tanzania	Madagascar Zambia Swaziland Botswana	Lesotho	Mozambique Malawi Namibia Angola Zimbabwe Mauritius

Own analysis based on figures given in Table 1

3.1.2 The importance of balanced diets

Undernourishment is directly dependent on the balance of dietary intake, expressed as the contribution of the macronutrients (i.e. carbohydrates, proteins and fats), as well as several micronutrients (i.e. vitamins, minerals and certain organic acids) in the diet. Micronutrients are needed throughout life in much smaller quantities than macronutrients. Micronutrient malnutrition is sometimes referred to as the 'hidden hunger' (IFA, n.d.) and is a major underlying cause of numerous health problems, especially in developing countries (Bell and Dell, 2008).

Given the FAO/WHO guidelines of 55–75% of total energy from carbohydrates, 10–12% from protein and around 15% from fats, the populations of almost half of the countries in southern Africa have too many carbohydrates in their dietary intake, and all countries are either below or just within the targets for protein (data not shown). Carbohydrate-biased diets (more than 70% of energy intake from carbohydrates) are found in the DRC, Madagascar, Malawi, Mozambique, Lesotho, Tanzania, Zambia and Angola. Protein deficits are most acute in the DRC, Mozambique, Madagascar and Angola, but at a minimum in Tanzania, Zambia, Zimbabwe and Malawi. Fat deficits are measured in Madagascar, Malawi, Lesotho, the DRC and Tanzania.

Iron deficiency is the most common micronutrient deficiency in the world. In southern Africa, dietary iron available for human consumption is highest in Malawi, Botswana and Lesotho, and lowest in Angola, Mozambique and Madagascar (data not shown). Vitamin A available for human consumption, commonly known as the anti-infective vitamin (Semba, 2001), is highest in Namibia and Angola, and lowest in Malawi, the DRC, Zambia, Mozambique, Lesotho and Zimbabwe. The share of retinol, which is the animal form of Vitamin A, available for human consumption is highest in South Africa, followed by Mauritius, Zimbabwe, Swaziland and Lesotho.

3.1.3 Food consumption

Per person food consumption levels range widely between countries but have remained stable on average since the early 1990s (Table 3). The strongest declines in consumption between the periods 1990–1992 and 2003–2005 were in the DRC, Tanzania and Madagascar. Malawi increased consumption the most, followed by Namibia, Mauritius and Angola.

When various food groups were analysed (data not shown), it emerged that average cereal and starchy root consumption over the period 2003–2005 are almost equal at approximately 350 g/pp/day. Milk consumption

stood at 100 g/pp/day, alcoholic beverage consumption at 90 g/pp/day and fruit consumption at 85 g/pp/day.

3.1.4 Food production

There are three sources of food for consumption, namely own production (nationally), net imports (imports-exports) and food aid, with large differences between countries. Average own production declined slightly from 1 475 g/pp/day over the period 1990–1992 to 1 453 g/pp/day over the period 2003–2005 (Table 4).

Most of the region's own production (2003–2005) comes from starchy roots, followed by sugar and sweeteners, and cereals (Table 5). The largest increases in production between the period 1990–1992 and the period 2003–2005 occurred for alcoholic beverages, eggs, fish and seafood, and starchy roots (mostly cassava). The largest decreases over the same period were for animal fats, oil crops, vegetable oils and fruits. Cereal production in the region declined by 8%.

Table 3: Food consumption (g/person/day)

Country name	1990-1992	1995-1997	2003-1995	% change 1990-1992 to 2003-2005
Malawi	882	1 038	1 342	52%
Namibia	1 136	1 132	1 387	22%
Mauritius	1 363	1 494	1 617	19%
Angola	1 021	1 099	1 161	14%
Mozambique	1 075	1 082	1 150	7%
Swaziland	1 380	1 246	1 438	4%
South Africa	1 470	1 414	1 483	1%
SADC average	1 198	1 178	1 237	0%
Lesotho	1 048	1 080	1 036	-1%
Zimbabwe	843	775	817	-3%
Zambia	999	990	945	-5%
Botswana	1 404	1 360	1 272	-9%
Madagascar	1 273	1 184	1 111	-13%-
Tanzania	1 648	1 411	1 335	-19%
DRC	1 643	1 308	1 100	-33%

Source: FAO

Table 4: Own food production (g/person/day)

Country name	1990-1992	1995-1997	2003-2005	% change 1990-1992 to 2003-2005
Angola	896	997	2 025	126%
Malawi	934	1 227	1 641	76%
Namibia	1 605	1 748	1 995	24%
Mozambique	1 181	1 323	1 408	19%
South Africa	2 074	2 060	2 132	3%
SADC average	1 475	1 408	1 453	-0%
Zambia	956	951	921	-4%
Lesotho	532	608	499	-6%
Botswana	784	781	710	-9%
Swaziland	2 926	2 526	2 636	-10%
Zimbabwe	956	1 047	830	-13%
Mauritius	2 041	1 904	1 712	-16%
Madagascar	1 644	1 488	1 277	-22%
Tanzania	1 929	1 619	1 482	-23%
DRC	1 937	1 438	1 082	-44%

Source: FAO

Table 5: Food production per food group (g/pp/day)

	1990 to 1992	1995 to 1997	2003 to 2005	% change 1990–1992 to 2003–2005
Alcoholic beverages	24	29	34	42%
Eggs	1	1	2	35%
Fish, seafood	25	29	29	16%
Starchy roots	152	141	174	15%
Pulses	7	8	8	7%
Meat	17	16	16	-5%
Vegetables	22	22	20	-7%
Cereals excl. beer	81	95	75	-8%
Sugar & sweeteners	97	83	85	-12%
Offal	2	2	1	-18%
Milk excl. butter	26	21	21	-20%
Fruits excl. wine	41	32	33	-22%
Vegetable oils	3	2	2	-26%
Oilcrops	14	13	10	-27%
Animal fats	1	1	1	-44%

Source: FAO

3.1.5 Food imports, exports and cereal food aid

Food imports (g/pp/day) increased by 13% for the whole region from 358 g/pp/day in 1990–1992 to 405 g/pp/ day in 2003–2005. The largest increases in imports occurred in Tanzania and Madagascar, and the largest declines in Malawi and Lesotho over this time period. Most of the region's food imports are cereals, followed by milk, sugar and sweeteners, fruits, vegetable oils, as well as fish and seafood. The largest increases in imports over the period from 1990–1992 to 2003–2005 were for fish and seafood and vegetable oils. The largest decreases in imports over the same period were animal fats and oil crops.

Food exports (g/pp/day) increased by 22% for the whole region from 303 g/pp/ day in 1990–1992 to 369 g/pp/day in 2003–2005. The biggest exporters in relation to their populations are Swaziland, Mauritius and Namibia. The largest increases in exports were in Zambia – although from a very low base – and Namibia. Exports came to a standstill in the DRC and Lesotho, with substantial decreases in Botswana, Zimbabwe and Madagascar. Most of the region's food exports are sugar and sweeteners, followed by fish and seafood, alcoholic beverages, fruits (excl. wine) and cereals (excl. beer). The largest increases in exports over the period 1990–1992

to 2003–2005 were alcoholic beverages and vegetable oils. The largest decreases in exports over the same period were offals, oil crops and meat.

Cereal food aid (g/pp/day) decreased by 56% for the whole region from 44 g/pp/day in 1990–1992 to 19 g/pp/day in 2003–2005. The largest increases in cereal food aid were in South Africa, although from a very low base, and in Tanzania. Food aid declined fastest in Mauritius, Botswana, Mozambique and Malawi. Most food aid (per person) flows to Lesotho, followed by Zimbabwe and Swaziland. The DRC, Tanzania and Madagascar, countries with the highest prevalence of undernourishment, receive very little food aid per person.

3.1.6 Value of trade

The value of food exports and imports compared with both the rest of the world and within the SADC region, increased rapidly over recent years (Table 6). However, the value of imports increased more rapidly than exports. Net exports turned negative in 2002 and have rapidly declined since then. The terms of trade (ToT) also declined by an average of 1.9% pa from 2000 to 2006. The ToT between SADC countries and the rest of the world declined more (-3.1% pa) than the ToT between SADC countries themselves (-0.9%).

The highest value exports in the region are sugar and sweeteners, fish and seafood, and fruits – together almost accounting for 77% of all food exports from SADC countries. These groups have also shown substantial growth in exports over the period 2000–2006. Despite specialisation in these higher value food groups, and as evident by the declining terms of trade, it was not enough to offset the increasing costs of food imports. The main reason for this is the declining ratio between the sugar price index and the cereal price index over time. This means that cereals (the main food import into SADC), have become more and more expensive in relation to sugar (the main export from SADC) over time.

3.1.7 Food prices

Food prices are not stable and it can be expected that this will impact on consumption. International food prices started rising rapidly in 2006, peaked in 2007 and dropped again in 2008 and 2009. Local producer prices are equally volatile. For cassava, the highest year-on-year increase on producer prices was almost 1 000% in Malawi, from US$22/t in 1995 to almost US$220/t in 1996, and almost 200%, also in Malawi, from $US42/t in 1999 to $120/t in 2 000 (Figure 1). Cassava producer prices increased to over $US200/t in Mozambique and Malawi in 2007.

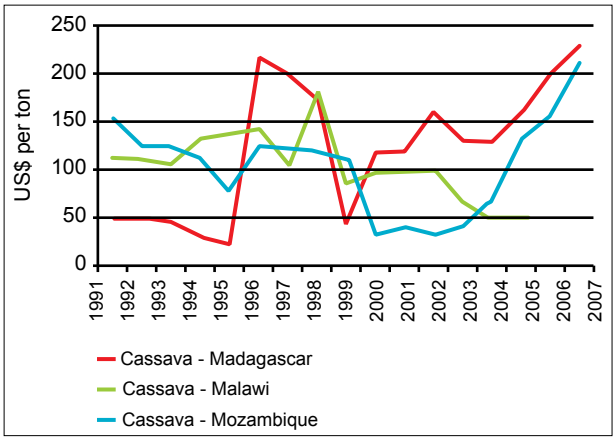


Figure 1: Domestic cassava prices in selected countries, 1991–2007

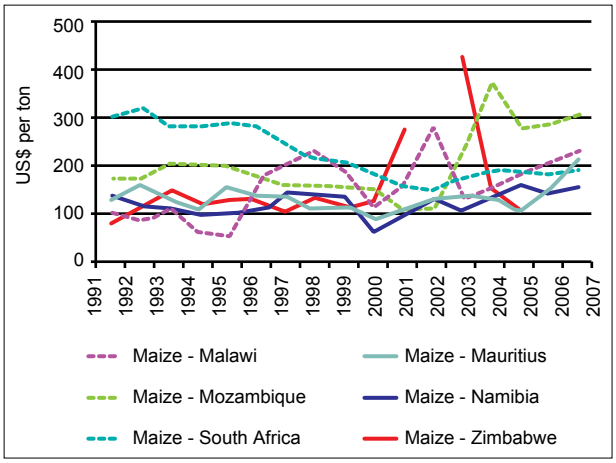


Figure 2: Domestic maize prices in selected countries, 1991–2007

Table 6: Value of SADC food imports and exports, US$bn

	2000	2001	2002	2003	2004	2005	2006	Average % change pa 2000–2006
Exports – world	3.60	3.56	3.71	4.83	5.79	6.48	5.96	9.4%
Exports – intra SADC	4.44	4.10	4.35	5.54	6.91	8.13	9.21	15.4%
Imports – world	2.67	2.36	3.19	3.76	4.60	4.71	5.64	15.9%
Imports – intra SADC	5.19	5.06	5.41	6.65	9.53	10.70	11.51	17.4%
Exports minus imports	0.18	0.24	-0.54	-0.04	-1.42	-0.79	-1.97	-170.0%
Term of trade – all	1.02	1.03	0.94	1.00	0.90	0.95	0.89	-1.9%%
Terms of trade – world	1.35	1.51	1.16	1.29	1.26	1.38	1.06	-3.1%-
Terms of trade – SADC	0.86	0.81	0.80	0.83	0.73	0.76	0.80	-0.9%

For maize, the highest year-on-year increase was almost 300% in Malawi from 1995 to 1996, and almost 120% in Namibia from 2002 to 2003 (Figure 2). In more recent years maize producer prices have changed year-on-year from -9% in Mozambique in 2005–2006 to a high of 47% in South Africa in 2006–2007. Thus, local prices of staples are very volatile.

3.1.8 Income

Not only food prices impact on consumption, but also income. Per capita average income was approximately 3 700 PPP$ (purchasing power parity US Dollars) over the period 2004–2006, up from an average of almost 2 000 PPP$ over the period 1990–1992. On this measure Botswana, Mauritius and South Africa were the most successful economies (Table 7). Zimbabwe, the DRC, Malawi, Mozambique and Madagascar had the lowest per capita income of less than 1 000 PPP$. Growth in per capita income over the period 1990–1992 to 2004–2006 was highest in Mozambique, Botswana and Mauritius. Both the DRC and Zimbabwe have shown negative growth in per capita income over this period. In more recent years (2000–2002 to 2004–2006), per capita growth was the highest in Angola, Namibia, Mozambique and Botswana.

3.1.9 Relative size of the agricultural sector

The agricultural sector varies in size from 2–5% of GDP in Botswana, South Africa and Mauritius, to 30–55% in Tanzania, Malawi and the DRC. More specifically, the agricultural population per hectare of arable and permanent crop land varies considerably (Table 8). The highest population densities on agricultural land are found in the DRC, Madagascar, Malawi and Mozambique. Zambia, a country with a relatively high number of undernourished people, is an exception with an agricultural population of only 0.9 people per hectare.

Table 8: Agricultural population per hectare of arable and permanent crops land

Country name	1990–1992	1995–1997	2003–2005
Angola	2.3	2.6	3.1
Botswana	1.2	1.6	1.6
DRC	3.4	3.8	4.5
Lesotho	2.1	2.2	2.2
Madagascar	2.9	3.1	3.7
Malawi	4.1	4	3.6
Mauritius	1.6	1.4	1.2
Mozambique	3	3.2	3.3
Namibia	1.2	1.1	1.1
South Africa	0.5	0.4	0.4
Swaziland	1.8	1.9	1.8
Tanzania	2.2	2.5	2.8
Zambia	0.7	0.8	0.9
Zimbabwe	2.4	2.4	2.3

3.1.10 Risks to undernourishment: summary

In summary, from a food systems perspective southern Africa can be characterised as highly undernourished, with a low and unbalanced dietary intake, stagnating consumption and own production of food (mostly starchy roots), slightly increased food imports (mainly cereals), increasing food exports (mainly sugar and sweeteners, fish and seafood, alcoholic beverages and fruits), and rapidly declining food aid. The key question to be addressed is: which variables within this food system have the relative highest impact on undernourishment in the region?

3.2 Key correlations with undernourishment

The main results when food system variables are correlated to undernourishment in SADC are presented in Table 9 on the next page.

Table 7: Per capita income (PPP$ and percentage growth)

	1990–1992	1995–1997	2000–2002	2003–2005	2004–2006	GDP PPP % change 1990–1992 to 2004–2006
Mozambique	268	352	529	665	719	168%
Botswana	5 240	6 542	9 393	11 884	12 751	143%
Mauritius	4 329	6 051	8 079	9 314	9 878	128%
Angola	2 486	2 365	2 781	3 489	4 515	82%
Namibia	3 155	3 535	4 021	4 955	5 497	74%
Lesotho	654	823	946	1 053	1 112	70%
Tanzania	638	688	827	1 007	1 082	69%
Swaziland	2 923	3 393	3 993	4 574	4 825	65%
South Africa	5 363	5 920	6 824	7934	8513	59%
Malawi	433	541	574	628	660	53%
Madagascar	679	685	752	795	836	23%
Zambia	1 015	865	957	1 098	1 166	15%
Zimbabwe	232	248	245	207	199	–14%
DRC	397	278	228	259	276	–30%

Source: *Economywatch*.com

Table 9: Main correlations between food system variables and undernourishment

Food system variable	Correlation	Average (g/pp/day)	Standard deviation (g/pp/day)	Covariance
Large, negative correlation				
C_protein	–0.8	53	15	0.28
C_fruit	–0.75	85	56	0.66
Cons	–0.73	1 128	221	0.18
C_carbs	–0.72	1 110	200	0.18
C_starch	–0.7	348	239	0.69
P_own	–0.61	1 453	613	0.42
P_pulse	–0.61	8	6	0.78
C_alcbev	–0.57	89	58	0.65
P_fruit	–0.51	33	30	0.92
C_fat	–0.50	45	18	0.40
Medium, negative correlation				
C_cereal	–0.49	344	120	0.35
C_oilcrop	–0.48	8	4	0.51
GDP PPP	–0.48	3 071	3 741	1.22
P_starch	–0.44	174	160	0.92
C_meat	–0.36	50	34	0.67
P_cereal	–0.34	75	45	0.61
C_pulse	–0.32	21	11	0.51
P_sugar	–0.32	85	187	2.2
P_aclbev	–0.31	34	27	0.78
P_oilcrop	–0.31	10	8	0.78
Small, negative correlation				
P_veg	–0.29	20	17	0.85
C_vegoil	–0.25	17	10	0.61
P_fish	–0.21	29	87	2.99
P_meat	–0.19	16	11	0.67
Export	–0.16	368	691	1.88
C_fish	–0.08	21	15	0.72
P_vegoil	–0.06	2	2	1.04
Small, positive correlation				
C_veg	0	61	51	0.84
C_eggs	0	5	4	0.85
P_offals	0.01	1	1	0.86
C_sugar	0.02	48	30	0.61
P_eggs	0.02	2	2	0.93
C_offals	0.04	4	2	0.58
C_animfat	0.06	3	3	1.06
P_animfat	0.08	1	1	1.9
Import	0.16	416	495	1.19
P_milk	0.17	21	21	0.99
Aid_cereal	0.19	19	17	0.87
Medium, positive correlation				
Agric pop	0.43	2.47	1.13	0.46
Large, positive correlation				
C_milk	0.53	98	105	1.07

Note: C = consumption
P = production

Own production of food is important in addressing undernourishment. A South African schoolchild participates in a food garden project.

There is a strong relationship between increased overall consumption of food and decreases in the percentage of population undernourished. The quicker the rate of consumption increased, the faster the percentage of people who are undernourished decreased. This does not imply, however, that all consumption has the same positive effect on undernourishment. An increase in the consumption of protein is most strongly correlated with a decrease in the percentage of population undernourished, followed by carbohydrates. Changes in consumption of fat still plays a large role in reducing undernourishment, but less so than protein and carbohydrates. When analysed per food group, a decrease in undernourishment is most strongly related to an increase in the consumption of fruits, starchy roots and alcoholic beverages, with medium but still beneficial responses to an increase in consumption of cereals, oil crops, meat, and pulses.

When the covariance (COVAR) as a measure of deviations between countries is taken into account, it is clear that an increased consumption of carbohydrates and protein is relatively uniformly correlated to reducing undernourishment (lower COVARs). The increased consumption of fruits, starchy roots, oil crops and alcoholic beverages is strongly correlated to a reduction in undernourishment, but not uniformly so in all countries (higher COVARs).

Own production of food (nationally) also matters in addressing undernourishment, but to a lesser degree than consumption. The quicker the rate of total own production increased/decreased, the faster the number of people undernourished decreased/increased. This is especially the case for the production of pulses and fruit, and to a lesser extent for starchy roots and cereals. The relatively high COVAR values for the production of these food groups indicate that there are relatively large deviations between countries in the relationships between decreasing undernourishment and increasing food production.

Neither changes in food imports and exports nor changes in cereal food aid have contributed meaningfully to a decline in undernourishment for the region as a whole. Correlations are small and low COVAR values suggest that this result is uniform across countries.

There is only a medium negative correlation between changes in income as measured by GDP PPP per capita and changes in the percentage of population undernourished. However, the COVAR of GDP PPP across SADC countries is very large, signaling very high differentiation between countries. It can therefore not be expected that a positive change in income will have a uniform positive impact on undernourishment in the region.

There is a medium positive correlation between the agricultural population per hectare and undernourishment, meaning that increasing agricultural populations are correlated to some extent with an increasing percentage of undernourished populations and vice versa. This correlation is relatively uniform across countries, although some differentiation does occur.

3.3 Income and price analysis

Changes in income are also possibly important for an analysis of undernourishment. The income elasticity of consumption measures the change in consumption to a change in income. If the income elasticity is >1, the consumption is income elastic and can be classified as a luxury good – meaning that demand for food proportionally increases more if income rises. If income elasticity is <1 and >0, then the good is income inelastic and can be classified as a normal good. If income elasticity is <0, the good is income inelastic or can be classified as an inferior good – demand decreases when consumer income rises.

Countries where food consumption has become a luxury good from 1990–1992 to 2003–2005 include Malawi and the DRC (Table 10). Countries where food consumption was an inferior good over the same period include Madagascar, Zambia, Tanzania, Botswana and Lesotho. There is a discernable shift towards higher income elasticities over time. The biggest shifts in income elasticities between the periods 1990–1992 to 1995–1997 and 1995–1997 to 2003–2005 occurred in Madagascar (-7.49 to -0.38) (much less inferior), Tanzania (-1.86 to -0.12) (much less inferior), Angola (-1.57 to 0.12) (from inferior to normal good), the DRC (0.68 to 2.25) (much more luxury good) and Malawi (0.71 to 1.83) (much more luxury good).

We also tested how sensitive the number of undernourished people is to changes in income. We calculated the percentage change in the number of undernourished people divided by the percentage change in income. One would expect the sign to be negative, that is, an increase/decrease in income would lead to a decrease/increase in the number of people undernourished. This clearly happened in the DRC, Zambia, Malawi and Angola in the early nineties; in the DRC, Namibia, Malawi and Mozambique in the mid- to end-nineties; and only to some extent in Mozambique and Angola over the period 2000–2002 to 2004–2006 (Table 11). A separation between changes in income and undernourishment occurred during the later periods. Therefore, income growth had less and less of an impact on reducing undernourishment.

More problematic, however, is that an increase/decrease in income tends to be associated more with an increase/decrease in undernourishment. This is counterintuitive, but does suggest that the gains of per capita income growth do not lead to a reduction in undernourishment, and may even reinforce it (especially in the DRC, Madagascar and Malawi). It is only in the very high growth economies of Angola and Mozambique where small positive changes between income growth and a reduction in undernourishment are observed from 2000–2002 to 2004–2006 (i.e. 1% change in income leads to a 0.07% reduction in undernourishment in Angola, and 0.14% reduction in Mozambique). Angola and Mozambique both displayed average economic growth rates of almost 16% and 10% pa, respectively, over the period 2000–2008.

This suggests that an average rise in per capita income does not benefit those affected by undernourishment most and where it does, very high rates of income growth are required. It is concluded that rising average income in southern Africa dissipates to other goals rather than addressing undernourishment.

Apart from income, prices are one of the most important factors affecting consumption. To answer the question on how sensitive undernourishment is to changing prices we calculated the price elasticity of undernourishment – the percentage change in the number of undernourished people divided by the percentage change in international food prices (Table 12). It is evident that undernourishment in all the countries became remarkably inelastic (0.35) to international prices in recent years compared to the early nineties (3.51). The highest sensitivity (although still inelastic) in more recent years (2000–2002 to 2004–2006) is in the DRC: a 1% change in international prices is associated with a 0.71% change in the number of undernourished people in this country.

Table 10: Income elasticities of consumption

	1990–1992 to 1995–1997	1995–1997 to 2003–2005	1990–1992 to 2003–2005
Angola	-1.57	0.12	0.34
Botswana	-0.13	-0.08	-0.07
DRC	0.68	2.25	0.95
Lesotho	0.12	-0.15	-0.02
Madagascar	-7.49	-0.38	-0.74
Malawi	0.71	1.83	1.16
Mauritius	0.24	0.15	0.16
Mozambique	0.02	0.07	0.05
Namibia	-0.03	0.56	0.39
South Africa	-0.37	0.15	0.03
Swaziland	-0.60	0.44	0.07
Tanzania	-1.86	-0.12	-0.33
Zambia	0.06	-0.17	-0.66
Zimbabwe	-1.17	-0.33	0.29

Table 11: Income elasticities of undernourishment

	1990–1992 to 1995–1997	1995–1997 to 2000–2002	2000–2002 to 2004–2006
Angola	-0.28	0.08	-0.07
Botswana	1.34	0.57	0.00
DRC	-4.44	-2.09	0.93
Lesotho	0.00	3.34	0.00
Madagascar	41.21	1.32	0.74
Malawi	-0.56	-0.90	0.57
Mauritius	0.00	0.00	0.00
Mozambique	0.16	-0.16	-0.14
Namibia	2.08	-1.45	0.00
Swaziland	6.22	0.00	0.00
Tanzania	8.22	0.16	0.29
Zambia	-1.24	2.19	0.38
Zimbabwe	4.05	0.00	0.39

Table 12: Change in undernourishment and change in food prices

% change in undernourished/ % change in food price	% change 1990–1992 to 1995–1997	% change 1995–1997 to 2000–2002	% change 2000–2002 to 2004–2006
DRC	10.20	1.56	0.71
SADC	3.51	0.63	0.35
Tanzania	4.89	0.14	0.31
Malawi	1.07	0.22	0.30
Zambia	1.40	0.95	0.30
Madagascar	2.96	0.53	0.29
Zimbabwe	2.15	0.00	0.26
Mozambique	0.38	0.33	0.18
Angola	0.11	0.06	0.14
Lesotho	0.00	2.05	0.00
Botswana	2.57	1.03	0.00
Namibia	1.92	0.82	0.00
Swaziland	7.70	0.00	0.00
Mauritius	0.00	0.00	0.00

Source: Own analysis

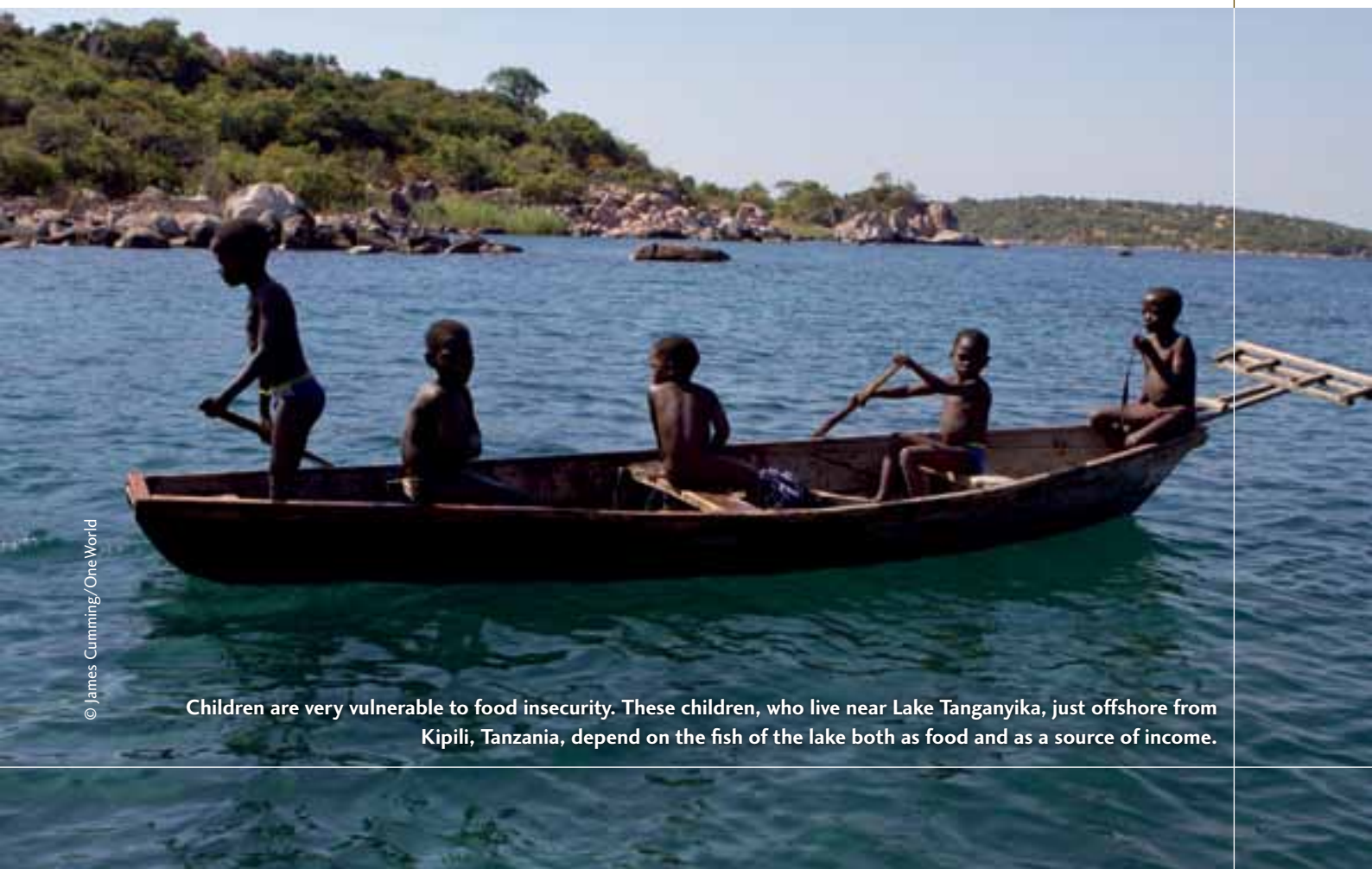
The correlation between year-on-year changes in domestic producer prices for the main staples of cassava, maize and cereals, and the changes in the international food and cereals price indices is not strong. The notable exceptions are Mauritius and South Africa, which are also both relatively open economies (Table 13).

Table 13: Correlation between changes in domestic producer and international food and cereal prices

	Food price index	Cereals price index
Maize – Mauritius	0.69	0.58
Maize – South Africa	0.47	0.62
Cassava – Malawi	0.36	0.39
Cereals, nes* – South Africa	0.35	0.47
Cassava – Mozambique	0.35	0.27
Maize – Namibia	0.34	0.14
Maize – Zimbabwe	0.26	0.15
Maize – Mozambique	–0.02	0.02
Potatoes – Malawi	–0.04	0.16
Cassava – Madagascar	–0.06	0.03
Maize – Malawi	–0.10	0.08
Rice – Madagascar	–0.21	–0.12

**not elsewhere specified*

This provides some evidence that for 1990–2007 rising international food prices are only weakly correlated to domestic producer prices of main staples in selected countries (see also Minot, 2011). These findings cast doubt on the thesis that domestic prices are mainly fueled by rising costs of imports. This may well be the case for Mauritius and South Africa, both countries which do not suffer from large undernourished populations. It seems that the reasons for undernourishment, at least in the longer term, should be sought elsewhere and rather than in rising international food prices alone.



Children are very vulnerable to food insecurity. These children, who live near Lake Tanganyika, just offshore from Kipili, Tanzania, depend on the fish of the lake both as food and as a source of income.

Subsistence agriculture does not provide sufficient food at household level, leading to reliance on food markets. A Malawian woman stands next to her season's maize harvest in Zomba District, Malawi. Each bag will feed her family of 6 for 5 weeks.

4. Food trade and local prices

Given the situation of undernourishment outlined above, the key drivers and entry points for making faster progress on reducing undernourishment must be identified. There is clearly not sufficient access to food at household level. From a food system perspective, markets and their ability to provide food to all at affordable prices play a key role.

Southern Africa still suffers from weak integration of food markets and erratic local prices. The current barriers to regional trade, lack of physical infrastructure, institutional failures and distorting legislation and policies are hindering the region's ability to provide food to those in need – when they need it and at reasonable prices. The region faces many challenges to its current agricultural and trade policies and strategies relating to production of and access to food, improving nutrition and liberalising trade within SADC (regional trade agreements). These have as yet not achieved notable success in terms of reducing undernourishment. Although liberalisation in trade policy has progressed substantially, inconsistent policies with the SADC free trade protocol related to export and import licenses, as well as temporary import bans on agricultural commodities, are still evident. An improvement in regional trade remains a preferred response option to absorb shocks in the food system.

As discussed in an earlier section, food exports for the whole of the SADC increased by 22% over the period 1990–1992 to 2003–2005. However, increases in exports were large from some countries but in other countries came to a virtual standstill. Food imports for the whole of the SADC increased by 13% over the same period, also characterised by large differences between countries. Overall in SADC, the value of food exports deteriorated in relation to the value of imports. The terms of trade for SADC declined by an average of 2% pa from 2000–2006.

These developments took place against the backdrop of a proliferation of regional trade agreements in eastern and southern Africa. In a World Bank policy research working paper, De La Rocha (2003) argued that the regional trade agreements in eastern and southern Africa are characterised by their multiple and overlapping membership, complex structures, and eventually conflicting and confusing commitments. It is concluded that regional organisations in Eastern Southern Africa need to harmonise and rationalise their trade regimes. Similar conclusions are reached by others (e.g. Flatters, 2002).

Trade policies stretch further than the region alone. The 'Partnership Agreement between the members of the African, Caribbean and Pacific Group of States of the one part and the European Community and its Member States of the other part', otherwise known as the ACP-EC Agreement, was signed in Cotonou, Benin, in June 2000. This global agreement, concluded for a period of twenty years, is based on the following four principles:

- equality of the partners and ownership of the development strategies;
- participation (central governments as the main partners, partnership open to different kinds of other actors);
- a pivotal role of dialogue and the fulfillment of mutual obligations; and finally,
- differentiation and regionalisation.

The partnership established through this Agreement is based on three complementary pillars, namely:

- development cooperation;
- economic and trade cooperation; and
- a political dimension.

Should the regional trade agreement (RTA) in the eastern and southern Africa region be well designed and effectively implemented, they could fulfill their potential to assist the member countries in increasing their current low trade links and integrating global markets. In this perspective, De La Rocha (2003) supports the argument that the Cotonou Agreement could serve as a solid basis for the region to organise itself and to harness the benefits stemming from future Economic Partnership Agreements.

The Food, Agriculture and Natural Resources Policy Analysis Network (FANRPAN) also released a report on trade policies and agricultural trade in the SADC region in 2003 (FANRPAN, 2003). The report pointed out that liberalisation in trade policy has progressed substantially (at least for South Africa, Tanzania, Zambia, Malawi and Namibia), but policies inconsistent with the SADC free trade protocol related to export and import licenses as well as temporary import bans on agricultural commodities are still evident.

Some earlier studies argued that improved trade in the SADC region can contribute substantially to improved food security (Maasdorp, 1999), but such hopes seemed not to have materialised so far.

No final conclusions on the possible linkages between trade and food security within SADC and between SADC countries and the rest of the world can be drawn at this stage. It is a recommended that a comprehensive evaluation of trade policies on food security and undernourishment in SADC is done. At this stage it can be concluded that existing trade agreements, within and outside SADC, have not convincingly contributed to an increased terms of trade for food in the region. To understand how much these agreements have or have not contributed would require more specific analysis on the subject.

5. Climate change: an added stressor

The above analysis shows that undernourishment and lack of food security is a critical problem in many parts of southern Africa. Food shortages are determined not only by local production failures, which are sensitive to environmental stressors, but also failure to access food at household level. The latter is driven mainly by socioeconomic issues, including poverty and conflict. Climate is thus one of many drivers of food insecurity, and all of its components are vulnerable to climate-related stress (Ziervogel and Ericksen, 2010): production, harvest, storage, distribution and marketing can all be affected by variable and unpredictable rainfall, and extreme climate events. Southern Africa has already felt significant impacts of more frequent droughts and floods, and high climatic unpredictability over the last two decades or so. Efforts to reduce undernourishment must be contextualised within current and future risks to food systems associated with climate change and climate shocks. It is expected that with continuing climate change the region will suffer an overall decline in agricultural production, with particular risks to maize and wheat production (Lobell *et al.*, 2008). This would exacerbate the situation of widespread hunger.

5.1 Climate change trends and projections

Global warming is as evident in Africa as in other parts of the globe (Boko *et al.*, 2007). Mean annual temperatures have increased across southern Africa over the last 40–50 years, and the number of hot days per year has increased whereas the number of cold nights per year has decreased (Boko *et al.*, 2007). Regional climate change projections (Christensen *et al.*, 2007) indicate that southern Africa will warm by between 3.1˚C and 3.4˚C, with warming of up to 4.8C° possible towards the end of the 21st century. Heat stress events will be more frequent in future (Battisti and Naylor, 2009), and it is likely that heat thresholds will be exceeded more regularly. Warming could be higher during late winter and early spring (Hewitson, 2007). Strong warming before the start of the rains and the planting season would significantly reduce soil moisture during this period through high rates of evapotranspiration from plants and soil. Warming also increases evaporation of water from surface bodies such as reservoirs and wetlands. Other impacts of warming include loss of crop suitability and biodiversity, and increased frequency and intensity of wildfires.

The climate of the south-central to eastern regions of southern Africa is characterised by high inter-annual, inter-decadal and multi-decadal variability, particularly with respect to rainfall. Rainfall is strongly influenced by the movements of the Inter-tropical Convergence Zone (ITCZ), and El Niño Southern Oscillation (ENSO) (Lindesay and Vogel, 1990). The southern African region is prone to climatic extremes of prolonged droughts, dry spells during the rainy season, heavy rainfall, severe floods and flash floods (EM-DAT, 2011), which appear to be increasing in frequency and severity (Easterling *et al.*, 2000). Severe recurrent droughts and floods devastate crop and livestock production and thus escalate food insecurity, hunger and malnutrition.

The climate change projections for the medium to long term show reduced rainfall for much of the region in winter (May–July) (Christensen *et al.*, 2007), leading to overall drying trends in the winter rainfall south-west of the region. In mid- to late-summer (December to April), wetting is indicated in the eastern and northern parts of the region. However, there is still considerable uncertainty over rainfall changes in the summer rainfall regions.

Seasonal shifts in rainfall can be expected. In regions receiving most of their rainfall in summer, the arrival of the first summer rains is likely to become more unpredictable and occur later than at present, and the intervals between rainfall events could become longer, but rainfall amount and intensity could be higher in mid- to late-summer. This disrupts traditional cropping cycles and access to fields during harvest periods, contributing to yield reductions or total losses and thus food insecurity.

5.2 Potential impacts of climate change on food production

With persistent high levels of undernourishment, stagnant production and consumption, increasing import dependence and declining terms of trade, southern African countries have become increasingly vulnerable to shocks that may disrupt food supplies or diminish the ability to increase food consumption. Such shocks can take many forms such as a decline in employment and income, volatile market prices, communication and transport breakdowns and delays, droughts, floods, conflicts and war, and many others. The impacts of climate variability and climate change on production are already affecting the region's food system, a situation which is expected to become even more challenging in the future. The following is a brief synopsis (not comprehensive) of literature on the topic of climate change and food insecurity in Africa, and specifically southern Africa, where information is available.

An overall decline in agricultural production and farming income is expected:

- Jones and Thornton (2003) estimated a 10% aggregate reduction in maize production in Africa and Latin America, using climate data from the HadCM2 model to generate characteristic daily weather data for 2055.
- The World Resources Institute, based on Cline (2007), estimated that agriculture in SADC countries by 2080 will be negatively affected by approximately -15% to -50%. South Africa, Namibia, Botswana, Zimbabwe, Zambia, Malawi and Madagascar are expected to be the hardest hit.
- Akpalu *et al.* (2009) pointed out that a change in the amount of precipitation is the most important driver of maize yields. A 10% reduction in mean precipitation reduces the mean maize yield by approximately 4%. The results also suggest that changes in temperature affect maize yields: As the mean temperature increases from 21.4 to 21.6°C, the average maize yield increases by 0.4%, but only up to a point, as the gain in maize yields prompted by increased temperature begins to diminish as temperature increases further (Akpalu *et al.*, 2009).
- Regarding the ability of African farms to absorb temperatures increases, it turns out that soil moisture is a decisive factor; i.e. dry land farms are faced with above average temperature and precipitation elasticities, while irrigated farms, by contrast, have appeared resilient to temperature changes and may even, potentially, increase in value (Akpalu *et al.*, 2009).
- Lobell and his colleagues (Lobell *et al.*, 2008, 2011a, b) showed that the production of maize in southern Africa can be expected to be significantly negatively impacted by climate change. Maize does not cope well with periods of moisture stress and is also sensitive to warming, with temperatures above 30°C leading to yield reductions. Under a scenario of 1°C warming and optimal rainfed management, about 65% of present maize-growing areas would experience yield losses; this area rises to 100% under warming combined with drought conditions (Lobell *et al.*, 2011a, b).
- The outcomes of a cross-sectional study surveying over 9 000 African farmers show that African farms are sensitive to climate variation (Kurukulasuriya and Mendelsohn, 2008). Farmers' net revenue appeared to be lower in places with higher temperatures and temperature elasticity with respect to the net revenue of African farms is estimated to be -1.3, meaning that a 10% increase in temperature will lead to a 13% decline in net revenue.

Climate change impacts and vulnerability are not expected to be homogeneous across the region:

- Climate change is unlikely to impact the continent evenly. Climate changes themselves are not likely to be uniform; some areas will get wetter while others, in contrast, will become dryer. Exposure to climate extremes such as floods is often spatially differentiated and sometimes localised. The effects of changing rainfall patterns on soil moisture and crop production potential will be more serious in regions which are already marginal for rainfed agriculture. How many people will be affected depends on population pressure on arable land, and household and economic dependence on agriculture (Gbetibouo and Ringler, 2009;

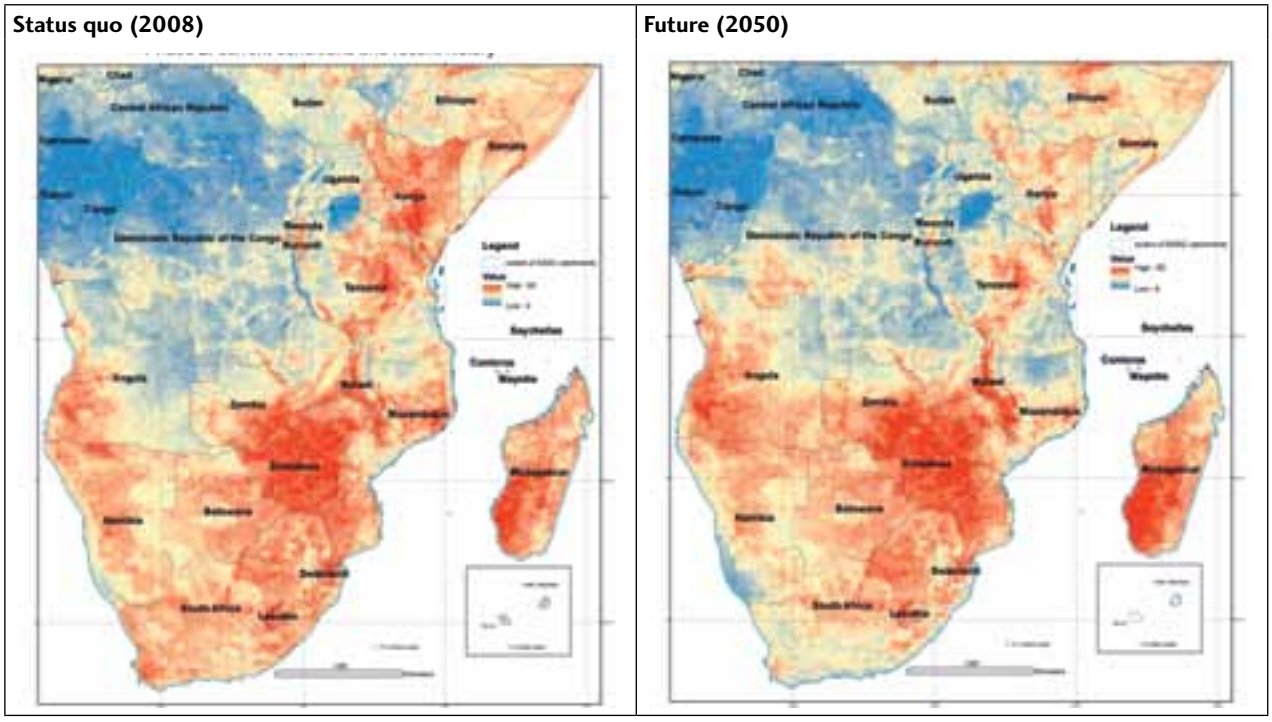


Figure 9: Map of current (left) and future (right) climate impact on food security and land-based livelihoods in southern Africa, showing areas of strong combined climate exposure and sensitivity (red) and areas of lower combined exposure and sensitivity (blue)

Source: Midgley *et al.*, 2011

Midgley *et al.*, 2011, see Figure 9). In addition, adaptive capacity, provided by access to financial and other resources, varies widely even at district and village level. These factors suggest that there remains a wide range of plausible outcomes (Kurukulasuriya and Mendelsohn, 2008).

Climate and climate change is only one driver of food insecurity and must therefore be seen as an added stressor:

- Food security depends on livelihood security, which is sensitive to many different factors. Household factors such as health status and access to health services play an influential role in food security. Food security is not solely about food production and availability (Ziervogel *et al.*, 2006).
- Thus climate variation is one of several interacting factors that affect food security. Referring to a meta-analysis on 49 household economy local-level studies done by Misselhorn (2005), Gregory *et al.*, (2005) point out that in studies of household food security in southern Africa, climate/environment was only one of some 33 drivers mentioned as important by householders.
- Misselhorn (2005) points out that the direct causes of inadequate food access are poverty, environmental stressors and conflict, underscoring the need to understand the multiple social and political dimensions of food insecurity, such as the breakdown in social capital associated with poverty, conflict and HIV/AIDS, that run deeper than environmental constraints to food production. Food insecurity is largely driven by chronic, structural elements in the life of communities. Food shortages are determined more by the ability to access food rather than by a local production deficit.
- Even moderate climatic shocks on top of entrenched vulnerability resulting from political and socio-economic factors (e.g. food prices, structural adjustments, policy response, conflicts, HIV/AIDS), can result in a food security crisis (Drimie and Casale, 2009; Scholes and Biggs, 2004; Vogel and Smith, 2002).

5.3 Adaptation for climate-food vulnerabilities

Governments, the private sector and households can respond in various ways to food insecurity. We provide a non-exhaustive list of documented and recommended responses at a regional level. Our rationale is that addressing the underlying, systemic causes of food insecurity in southern Africa will go a long way towards absorbing shocks brought about by expected increases in climate variability, and longer-term climate changes.

5.3.1 Improve regional trade

Regional trade is one way absorb the shock of highly volatile domestic prices (Haggblade *et al.*, 2008). It was found that regional trade flows can clearly help to soften supply deficits. Improved marketing and free cross-border trade is a way to address food security.

The rationale is that not all areas in the region are food insecure. Some areas, notably northern Zambia, northern Mozambique and southern Tanzania, regularly produce food surpluses (Govereh, 2007; Haggblade *et al.*, 2008). The existence of hotspots of surplus production and hotspots of food insecurity in the region suggest the need for more effective regional trade responses. This will have to be accompanied by an investment in transport infrastructure and a reduction in transport costs.

In a Zambian case study it was concluded that the closing of borders can easily lead to price volatility in the range of 100% from one year to the next. Uncertainties regarding government interventions such as export and import quotas and price subsidies, risk driving commercial traders out of the markets and exacerbates price volatility (Dorosh *et al.*, 2007).

Cross-border trade in staples is still restricted in many countries. Zambia, Malawi and Tanzania have all imposed export bans or trade restrictions on maize recently to protect domestic supplies (Jayne *et al.*, 2009). South Africa and Mozambique, in contrast, have open border policies.

Invest in transport infrastructure and reduce transport costs. Border delays and unreliable transport infrastructure lead to very high transport costs, impeding trade in the region (Venter, 2009; Foster and Briceño-Garmendia, 2009).

5.3.2 Prevent and absorb price volatility

A way to absorb domestic production and price shocks of the staple crop maize is to substitute for other staples such as cassava (Haggblade *et al.*, 2008). Production of cassava in the region has increased substantially in recent years.

Unreliable crop estimates in some countries are a contributing factor to price volatility (Jayne *et al.*, 2009). More accurate estimates of crop production are a sure way to reduce price volatility and resulting hardship and hunger caused by price spikes.

5.3.3 Integrate local policy responses

Reducing food security will require that social, economic and environmental determinants of vulnerability be integrated in local policies. Effective long-term agricultural policies must certainly be developed, but must also be integrated within a wider sustainable development framework, according to local and national situations, and be grounded in the local context (Ziervogel *et al.*, 2006).

5.3.4 Strengthen regional institutional and policy frameworks

Regional Economic Communities (RECs) are taking steps towards developing institutions and policy frameworks to support agricultural development in the face of climate change, but this requires further political commitment, investment, research, and institutional strengthening.

Importantly, climate change impacts are not expected to be homogeneous across the region but will emerge as transboundary hotspots, intensifying the need for investments which facilitate improved food trade between production surplus and deficit regions. Regional dialogue

Climate variation is one of several interacting factors affecting food security. A subsistence farmer in the Eastern Cape, South Africa.

which brings together role players and decision makers, for example the platforms provided by FANRPAN and CAADP (Comprehensive Africa Agriculture Development Programme), can play an increasingly important role in informing national and regional policy development.

5.3.5 Develop broader sociopolitical reform

Misselhorn (2005) pointed out that interventions aimed at drought mitigation and increased agricultural output will not alone ensure food security for southern Africa's rural poor. The findings suggest that the future determinants of food security in southern Africa lie primarily outside the domain of agricultural production. A focus on improving crop yields would neglect those economic (e.g. poverty, lack of employment, inflation and market failures) and sociopolitical factors (e.g. conflict, property rights, education and HIV/AIDS) that are undermining the coherence of the family unit and creating increasingly vulnerable and socially unstable communities.

5.3.6 Develop private agribusiness

The development of private agribusiness can be a means to address food insecurity and undernourishment. The agricultural industry does not only include farmers, but also suppliers of inputs (e.g. feed, seed, fertilisers, machinery, etc.) and output companies (e.g. marketing, transportation, groceries, restaurants, etc.) (Louw, 2007). Insufficient access to food, as a key driver of food insecurity and ultimately undernourishment, can be improved by better connectivity between farmers and output companies. There is very little incentive for farmers to produce surpluses that cannot be sold. In a study focused on South Africa and Zimbabwe, Van Rooyen *et al.* (2000) found that there is potential in certain agro-food chains for supply chain integration and co-operation between agribusiness. More recently, Vink *et al.* (2006) argued that a good case can be made for the high social returns that may be expected from foreign direct investment in agricultural and agribusiness. They also argue that "the securing of supply chains" is a positive step towards better access to food, and thus food security. However, more empirical work is needed on the specific role of agribusiness development to enhance food security and address undernourishment in the region.

5.3.7 Adapt production practices and increase irrigation

Greater resilience of food production systems could be achieved through locally suitable, tested and affordable technologies supported by strong extension.

Developing high temperature and drought resistant crops and promoting irrigation systems (where water supplies are secure) are direct strategies that can be joined with indirect strategies, such as developing other sectors of the economy in order to reduce the country's dependence on its agriculture and increase wealth, so that adapting to climate change becomes possible at a household level (Kurukulasuriya and Mendelsohn, 2008).

Hassan and Nhemachena (2008) recommend that policy-makers support farmers' adapting efforts by promoting farmer education and improving their access to climate forecasting, by investing in research that targets the development of farm-level climate adaptation technologies, by improving extension services, and also by opening access to credit and developing markets. Furthermore, these recommendations should be considered even more attentively in areas where dry land farming currently predominates.

Svendsen *et al.* (2009) recommended that in Africa returns on additional investment in irrigation would be high, both in terms of greater food security for the continent and greater production of export-quality agricultural goods.

Hassan and Nhemachena (2008) argued that resorting to irrigation poses several difficulties such as manipulating high technologies, having access to sufficient water resources, and to financial means of investments. Therefore, when switching from dry land to irrigation is not possible, alternative responses to climate change's negative impacts comes under the form of three major adaptation options: diversifying into multiple crops and favouring high temperatures resilient crops, mixing crop and livestock systems, or switching from crops to livestock (Jones and Thornton, 2009).

The consumption of fruits correlates very strongly to the reduction of malnourishment. A marketplace in KwaZulu-Natal, South Africa.

6. Discussion

Undernourishment is not only a cereal production and consumption problem. Much of the work on food insecurity in the region is focused on cereals. A focus on cereals alone when analysing the potential risks of climate change on southern African agriculture would be a mistake. Consumers, on average, have already started to substitute their staples away from cereals towards cassava, with growth in cassava consumption in especially Malawi, but also Lesotho and Zimbabwe and high levels of consumption in the DRC, Mozambique, Malawi, Angola, Tanzania, Madagascar and Namibia. Changes in cereals consumption and production are not strongly correlated to changes in undernourishment in the region while changes in consumption of starchy roots (mainly cassava) are strongly correlated. This means that the efficiency of cassava markets in the region needs much more attention. Domestic cassava prices, for example, show very large spatial and temporal variation. The possible effects of rising carbon dioxide, changing temperatures and changing precipitation on cassava production is a risk that needs to be quantified and managed appropriately (Gleadow *et al.*, 2009).

The consumption of fruits, although in relatively small quantities when compared to the staples, is correlated very strongly to undernourishment. Fruit production as well as consumption declined in the region as a whole, but in those countries where it declined the most, the rise in undernourishment was the worst. The impacts of climate and climate change on fruit production as well as the efficiency of fruit markets in the region need more specific attention. Furthermore, the region remains a consistent net exporter of fruits. This begs the question whether barriers to trade, and specifically fruit, within SADC have been sufficiently removed or whether access to fruit is 'only' a problem of affordability on a household level. The risks of a changing climate on fruit production also need further attention on a region-wide level.

Changes in imports and exports are weakly correlated to undernourishment, and the average positive net effects of food trade are declining. The value of exports of mostly sugar and sweeteners, fish and seafood, and fruits, together account for 77% of all food exports from SADC countries. Since 2002, this was not enough to offset the increasing cost of food imports. The price of cereals, which is the main food group imported, rose faster than the price of sugar, which is the main food group exported from the region. The exports of sugar did not have a negative impact on undernourishment (at least not directly), and the consumption of cereals (whether imported or produced) was not as strongly correlated with undernourishment as would have been expected. Countries that export sugar (mainly Mauritius and Swaziland) do not have very large undernourished populations, and countries that import the most cereals (Mauritius, Swaziland, Lesotho, Namibia and Botswana) are also not those with relatively larger undernourished populations.

It seems as if at least two major effects are at work that warrant further research: First, the positive effects of trade have not yet reached those countries with large undernourished populations and, second, countries that have experienced such positive benefits have seen a decline in undernourishment over time as relative prices of export and import food products have changed.

International food prices have had a relatively small effect on undernourishment. The sensitivity of changes in undernourishment to changes in the international food prices is relatively low and tends to decrease over time. Local staple prices also do not correlate well with international food prices, with the notable exception of Mauritius and South Africa, which are both relatively open economies.

Local conditions have had a bigger impact on food prices and put pressure on households' ability to cope. Local production and distribution conditions had a far greater influence on staple prices than international food prices. Domestic staple food producer prices, for example, have increased for seven years in a row, of which four years saw increases of 15% per annum and more. These cumulative price increases in staples have a large impact on poor households' ability to cope.

Not only prices, but also income affects demand. The somewhat counterintuitive results are that rising income in the region has not been associated with decreased undernourishment. It is only in the very high growth economies of Mozambique and Angola that rising incomes have been associated with some decreases in undernourishment. More work is needed on the nature of this transmission mechanism and the reasons why it is failing, but it seems as if rising average income in itself is not a way to address undernourishment.

Agriculture, where it demands a large share of economic activity, does not convincingly address undernourishment. The bigger the size of the agricultural sector in relation to a country's economy, the greater the number of undernourished people and the smaller the size of the agricultural sector in relation to the economy, the fewer the number of undernourished people. Undernourishment is strongly related to those countries that are stuck in (mainly) subsistence agriculture and have not yet diversified to more industry-, mining- and

service-driven economies. Addressing undernourishment cannot be done within the context of an economic diversification strategy that not only includes agriculture, but also secondary and tertiary activities in the more urbanised spheres of the region's economies.

Effective agricultural and trade policy and strategic context appear to be lacking. The many challenges that are acknowledged include the absence of a regional food reserve facility, over-dependence on rainfed agriculture, the need to promote private markets in agricultural products, and an improvement in rural infrastructure. Regional trade agreements in the region are characterised by their multiple and overlapping membership, complex structures and eventually conflicting and confusing commitments. Existing trade agreements within and outside SADC have not convincingly contributed to an increased terms of trade for food in the region.

Climatic variability has an impact on own food production in southern Africa. It is generally believed that African farmers are especially sensitive to climate variation, acknowledging that climate change is only one, and certainly not the most important, driver of food insecurity. An overall decline in agricultural production is expected, but climate change impacts and vulnerabilities are not expected to be homogeneous across the region. The vulnerability of the farming sector, taking into account adaptive capacity, is strongly differentiated across the region. This is linked to the country-specific nature of developmental constraints (De Graaff *et al.*, 2011).

6.1 Conclusion and recommendations

The main question we wanted to answer is where to focus efforts in addressing undernourishment in southern Africa. We used a systems approach, searching for relatively stronger relationships between undernourishment and other food system indicators. It can be concluded that the problem of undernourishment in the region is very strongly associated with a lack of food consumption, in turn influenced by a lack of own production. An interesting result is that although cereal consumption is associated with changing undernourishment, the effect is not as strong as for the consumption of mainly cassava and fruits. The surprisingly lower importance of cereals is also reflected in the relatively low importance of international food imports (mainly cereals) in relation to undernourishment in the region. Concerning undernourishment in southern Africa, cereals do matter, but not the most.

The effects of international food prices are less of a problem for undernourishment. Fluctuations in prices do not correlate well with international food prices, with the notable exception of Mauritius and South Africa which are both relatively open economies. Where this situation does become a problem with regard to undernourishment is with the persistently high increases and extreme volatility of local staple market prices throughout the region, much more so than local producer prices. The region has several net production and deficit hotspots that need to be integrated better to mitigate against any further shocks to the food system. The functioning of local food markets and factors driving market price formation remain crucially important in addressing undernourishment.

Average income plays less of a role in addressing undernourishment than what could have been expected. Rising incomes on a national level, fueled by strong recent economic growth, only start to affect undernourishment at very high levels of income growth. Economic growth has not convincingly 'trickled down' to better nourishment, and specific interventions on a household level are required. Such direct response options to support households are important, but not sufficient. Broader reforms in regional and international trade policy and the effective implementation thereof are needed to improve the overall food system in SADC and to address the persistent and growing problem of undernourishment in the region.

We propose that addressing these issues systematically would serve to provide increasing levels of resilience against climate-related shocks in the short term, and a good measure of adaptive capacity over the longer term as climate change and its impacts on southern Africa unfold. Increasing regional cooperation and policy development are required, and the progress made on the CAADP process is heartening. The process should be taken forward rapidly to include all southern African nations, with continued support from the RECs, as well as regional institutions which provide a critical platform for multi-stakeholder dialogue, such as FANRPAN. Political commitment, investment and underpinning research must be stepped up significantly for the region to make tangible progress in the war against hunger.

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Acronyms and abbreviations

CAADP	Comprehensive Africa Agriculture Development Programme
COVAR	Covariance
DFID	Department for International Development United Kingdom
DRC	Democratic Republic of Congo
ENSO	El Niño Southern Oscillation
FANRPAN	Food, Agriculture and Natural Resources Policy Analysis Network
FAO	Food and Agriculture Organisation of the United Nations
GDP	Gross Domestic Product
HIV/AIDS	Human Immunodeficiency Virus / Acquired Immune Deficiency Syndrome
ITCZ	Inter-tropical Convergence Zone
MDER	Minimum dietary energy requirement
MDG	Millennium Development Goal
PPP	Purchasing power parity
RCCP	Regional Climate Change Programme for Southern Africa
RECs	Regional Economic Communities
RTA	Regional trade agreement
SADC	Southern African Development Community
SSA	Sub-Saharan Africa
ToT	Terms of trade
UN	United Nations

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