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Rural poverty and Food insecurity mapping at district level for improved agricultural water management in the Limpopo River Basin

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Project information

The project targeting and scaling out undertakes research for development within the Limpopo Basin Development Challenge of improving integrated management of rainwater to improve smallholder productivity and livelihoods and reduce risk. The project developed an evidence and knowledge-based tool to assess and map the likelihood that a given intervention will be successful in given locations, at the basin scale. The project seeks to answer the question of what works where and why, leading to greater impact from localised successes within the Limpopo basin.

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Bumper harvest and crop diversification - the trajectory out of food insecurity and poverty
Photo: M. Magombeyi

On the contrary, crops affected by dry spells and droughts at different growth stages result in poor yield
in the Limpopo Basin
Photo: WaterNet

Abstract

The Challenge Program on Water and Food (CPWF) Phase II for the Limpopo Basin Development Challenge (LBDC) project aims to develop methods, processes, and technologies to help resource-constrained smallholder farmers mitigate poverty and food insecurity through improved agricultural water management (AWM) strategies. The purposes of this paper are to: 1) Identify areas in the Limpopo River Basin with high levels of rural poverty and food insecurity; 2) Identify areas where AWM interventions are taking place; and 3) Check whether current activities of the CPWF in the Limpopo Basin are located in areas of need as per poverty profiles and geographical location of smallholder farms. The generated poverty and food insecurity maps were based on food security surveys and estimates of consumption or income-based welfare outcomes at the district level from 2003–2013. Based on existing district level poverty and other relevant data in the basin, the study shows that the LBDC study sites are located in poor areas in the Limpopo Basin, and poverty reduction efforts should prioritize vulnerable female and child-headed households as they are the most negatively impacted by poverty and food insecurity in the four countries. Hence, with the overall aim of CPWF under LBDC to reduce poverty and food insecurity, and improve livelihoods, poverty indices should rank highly as one of the factors for project site selection. Poverty and food insecurity mapping plays an important role in identifying areas lagging behind in social and economic development, and also in facilitating targeted developmental programs such as education, health, access to credit, agricultural production support and food aid.

However, it should be recognized that using district-level information often masks the existence of poverty pockets in otherwise relatively well-off districts, which could lead to poorly targeted AWM schemes. In addition, the poverty index is limited by the subjective nature of community-level and household-level factors that influence it, and this is reflected by the responses from research participants. Whereas a common poverty line for a particular time frame enables poverty comparisons across countries, local level poverty assessments, however, usually require more in-depth and diverse information that can be used in designing cost-effective and efficient anti-poverty programs and livelihoods enhancement opportunities.

In order to achieve the research project's goals of poverty and food insecurity reduction, and livelihood enhancement of smallholder farmers in the Limpopo Basin, it is of greater significance to understand trends in poverty rates rather than 1-year values at CPWF-LBDC study sites. Poverty maps that highlight areas marginalized by resource constraints help in setting priorities for developing technologies and in deploying resources where they are most needed and likely to alleviate poverty and food insecurity. This work provides background information on the Limpopo Basin.

Keywords: Agricultural water management; Food insecurity; Mapping; Poverty level; Smallholder farmers

1: Introduction

The Limpopo River originates in central southern Africa and flows generally eastwards to the Indian Ocean, traversing a terrain encompassing an altitude of 1,600 m in South Africa (Drakensberg Mountains) to the sea level in Mozambique (Sullivan and Sibanda, 2010). Its length and drainage area are estimated, respectively at 1,750 km long and 430,000 km², respectively (LBFP, 2010) – (Figure 1), while the mean annual discharge at its mouth in Mozambique is 170 m³/s (Nakayama, 2003). The main tributaries of the Limpopo River are: the Olifants (Elephant); Luvuvhu and Crocodile rivers in South Africa; Shashe River in Botswana; and Mzingwane and Mwenezi rivers in Zimbabwe. Its basin (the Limpopo) is located between latitudes 20^0 S and 26^0 S and longitudes 25^0 E and 35^0 E. The rainfall in the Limpopo River Basin is seasonal (annual rainfall ranges from 200 to 1,500 mm with a mean of 530 mm) and is unreliable (LBFP, 2010). Hence, in dry years, the upper parts of the river flow for 40 days or less (Görgens and Boroto, 1997), affecting both crop and livestock production. In addition, inter-seasonal dry spells often occur during the rainy season and during critical periods of crop growth. Despite the high aridity (Alemaw et al., 2010) of the basin, rain-fed farming is the main production system (Sullivan and Sibanda, 2010). Occasionally, catastrophic floods may occur during the rainy season in the lower reaches. Of particular impact were the cyclone-triggered floods of February 2000 (Limpopo River Awareness Kit, 2011; FAO, 2004b; Nakayama, 2003) and January 2013.

The Limpopo Basin is the second most populated basin in the Southern African Development Community (SADC) region after the Orange River Basin (Limpopo River Awareness Kit, 2011; FAO, 2004b). It is home to more than 14.5 million people (2007 estimate), including 69% of Botswana's population, while that of South Africa, Mozambique and Zimbabwe are estimated at 22%, 7% and 10%, respectively (LBPTC, 2010). Despite attaining national-level food security, certain basin areas are faced with high poverty and food insecurity challenges due to both production declines and low purchasing power that negatively affect development (FEWS NET, 2012). On average, farmers in the basin only produce enough food to feed their families adequately for less than 8 months of the year (Cunguara and Darnhofer, 2011). Thereafter, households turn to the market to meet their food needs, e.g., purchase of maize meals during the cropping season from November to March. Increased agricultural productivity through research for development, in line with the FAO's 'twin-track' rural approach (Stats-SA, 2012), can play an important role in poverty reduction and enhancement of food security (LBFP, 2010), and have become central goals of the international development agenda (Ortiz et al., 2012). Poverty and food insecurity mapping can identify areas that fall behind in economic development, and also facilitate the targeting of poverty alleviation programs such as education, health, credit, agricultural production support, and food aid. Poverty mapping, as a policy tool, can assist in pinpointing various factors that influence its spatial distribution, e.g., livelihood strategies, including salaries and wages, remittances, social grants, and farming activities (forestry, crop/livestock).

Livelihoods are secure when households have secure ownership of, and access to resources and income-earning activities. By identifying livelihood zones (geographical areas within which households obtain things essential for life, e.g., food, cash, water, shelter, clothing, health care, and education – largely by the same production systems and patterns of trade/exchange), and the local factors which influence these things essential for life, the constituents of the zones can be highlighted (Altman et al., 2009). These factors include climate, soil, access to markets, and the price for sold goods. In the basin, drought, floods, availability of inputs/farm implements, markets, draught-power and low incomes and limited access to finance were ranked as the top livelihood challenges (ZimVac, 2011a). Proposed policy interventions such as implementation of improved agricultural water management (AWM) in the basin should ensure that livelihood strategies are robust enough to address the challenges of food insecurity, poverty, market access and water scarcity (droughts) and flooding.

Figure 1: Major rivers, dams, transport network and protected areas in the Limpopo River Basin
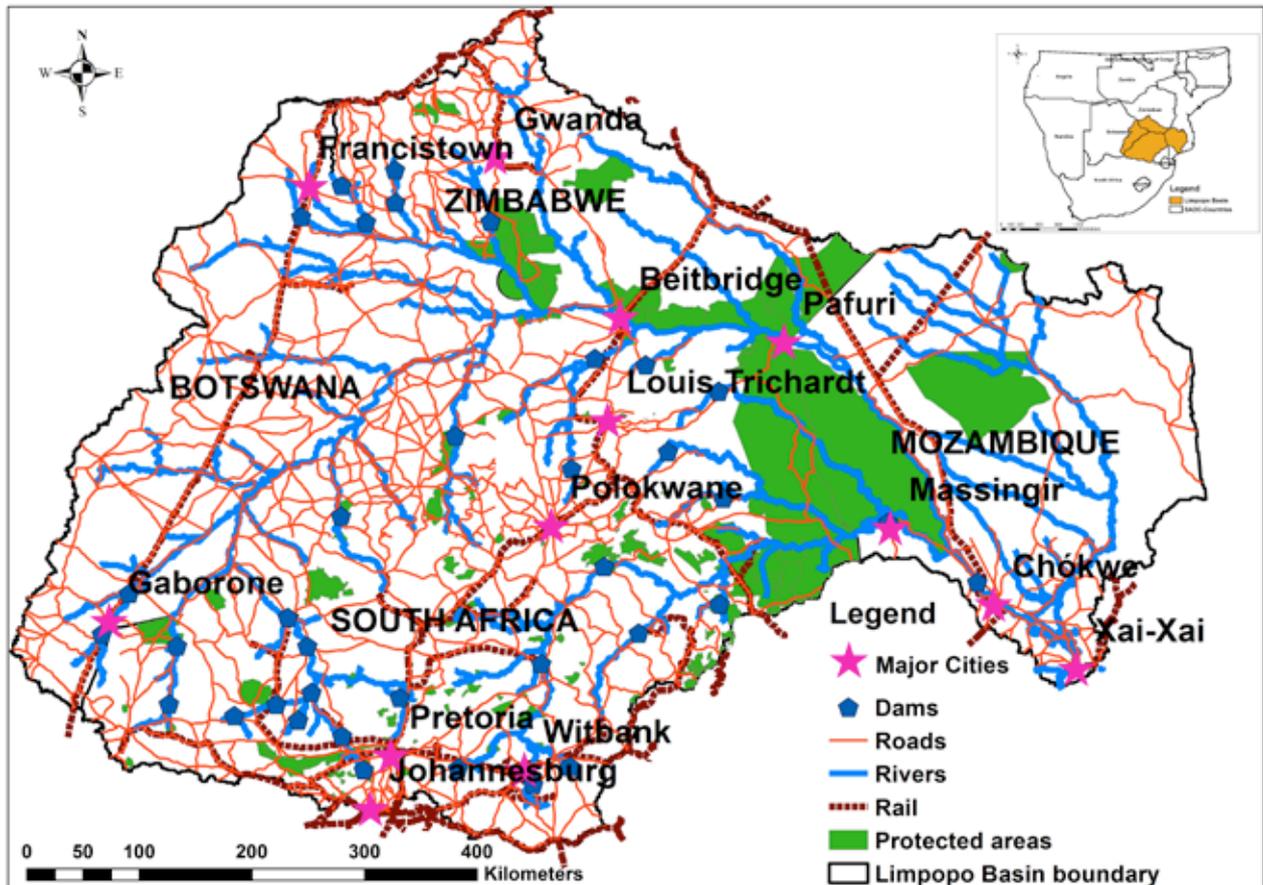
1.1   Purposes of this paper

The Challenge Program on Water and Food (CPWF) Phase II Limpopo Basin Development Challenge (LBDC) project aims to develop methods, processes, and technologies to help resource-constrained smallholder farmers mitigate poverty through improved rainwater management. The purposes of this paper are to:

1. Identify areas in the Limpopo River Basin with high levels of rural food insecurity and poverty;
2. Identify areas where improved AWM interventions are taking place;
3. Identify areas with a high density of rural smallholder farmers; and
4. Check whether current CPWF Limpopo Basin activities are located in areas of need as per livelihood zone strategies, poverty profiles and geographical location of smallholder farms.

This paper draws on national poverty indices that were constructed from data collected during the period 2003 to 2013, from nationally representative household surveys in the four Limpopo Basin countries. The paper describes the methods used to identify smallholder farming areas and to match these with selected LBDC sites under CPWF Phase II, including the Limpopo 1 project: 'Targeting and Scaling Out' (L1).

2: Poverty definitions

Poverty is considered a basic deprivation of well-being to live comfortably (Namara et al., 2010; PROVIDE, 2009), for example, lack of adequate food, shelter, education, health, and vulnerability to natural disasters such as floods and droughts. Chambers (1988) and World Bank (2008) identify five dimensions of poverty and they are: i) lack of adequate income or assets for generation of income; ii) physical weakness as a result of under-nutrition, disability or sickness; iii) physical or social isolation that affects access to goods and services; iv) vulnerability to risks; and v) 'voicelessness' or exclusion from decision-making processes (often through abuse of power) within the existing economic, political, cultural and social spheres. Hence, poverty has many dimensions that interact and reinforce each other in very complex ways (Smith, 2004). There is, for instance, a close relationship between low education levels of the poor and their low income; both reinforcing each other in ways that perpetuate poverty (Siphambe, 2003). Furthermore, low education levels can reinforce the exclusion of the poor from participating in decision-making processes that affect their lives, making the poor both voiceless and powerless.

The first step in poverty analysis is to decide on a suitable poverty indicator to use and the criteria of poverty dimensions to analyze, for example, income or expenditure indicators. Analysis of the poor usually entails measures of poverty, based on a poverty line (Lipton and Ravaillon, 1995) that separates the poor from the 'non-poor'. However, Woolard and Leibbrandt (1999) report that the point of separation is usually arbitrary. Hence, one individual might be classified as poor; while another earning a few cents more is classified as 'non-poor' (PROVIDE, 2009).

2.1   Poverty lines

There are several methods for setting poverty lines and they include: the Human Development Index (HDI); the Food Energy Intake Approach; the Cost of Basic Needs Approach (conventional approach); the US$1/day per person criterion (now adjusted to US$1.25/day per person) that is often used for international comparisons; and a Social Subjective Poverty Line (Booysen et al., 2005; Tarp et al., 2002). Another international poverty measure used specifically to determine water poverty is the Water Poverty Index (WPI) – (Sullivan, 2002).

However, poverty measures based on income or consumption have their associated challenges as survey designs vary between countries and over time, making country comparisons difficult (World Bank, 2001, 2013). On the one hand, measures of deprivation in terms of capabilities in health and education, which greatly impact on poverty, can overcome certain weaknesses in poverty measurement based on either income or consumption. However, data on both health and education are not always available on a regular basis in developing countries (Siphambe, 2003). Thus the data used in this paper are based on the best available from surveys conducted from 2003–2013. On the other hand, there are poverty assessment methods that address the vulnerability of the poor to different risks such as violence, crime, and natural disasters that are sometimes measured using a combination of participatory methods, polls, and national surveys that tap into the extent of civil and political liberties. Again, data for these poverty measures are not always available (LBFP, 2010; Siphambe, 2003). Challenges arise when generalizing poverty data, where a person is considered to be poor according to one poverty dimension and yet not noted as poor based on other dimensions (Siphambe, 2003). For instance, should a person who is not income poor but who is unhealthy and illiterate, be classified as generally poor or not?

Most countries have two poverty lines (World Bank, 2001, 2008): i) a food poverty line, based only on the income needed for sufficient calories or based on prevailing consumption patterns of a basket of basic goods (sometimes called the extreme poverty line); and ii) a poverty line that makes an allowance for the

costs of non-food needs. The international poverty line was reset based on a purchasing-power parity (PPP) to US$1.25/day per person in 2005 to cater for cost variations in food and non-food needs in many locations (World Bank, 2008).

The choice of a poverty line is crucial when analyzing the poverty status, as it determines the outcomes of poverty comparisons. This makes it difficult, if not impossible, to make poverty comparisons across the different countries in the Limpopo River Basin that use different poverty measures. Furthermore, we recognized that the choice of a poverty line in different countries was arbitrary. The Small Area Estimation (SAE), which is a mathematical technique to extract more detailed information from existing data sources by statistical modelling, may be used for providing comparisons of poverty at a fine level in different countries (Elbers et al., 2003; Rao, 1999), but it too cannot always tap into poverty variances with certainty.

In general, an individual, household or community is said to be poor when it falls short, in relative or absolute terms, of a threshold level of welfare, referred to as the poverty line (Namara et al., 2010; Rao, 1999). Relative poverty measures the extent to which a household's income falls below an average income threshold in a given society's economy, while absolute poverty measures the number of people that fall below a certain income threshold, which makes them unable to afford certain basic goods and services required to sustain a healthy life (Namara et al., 2010).

2.2   Food security

According to the FAO (2004a), the definition of food security has four interconnected dimensions namely, availability of food, access to food, utilization of food, and stability of available food at a household level. Food insecurity occurs when one or more of these dimensions are weakened, as no single dimension assures food security on its own (Stats-SA, 2012). The three temporal variants of food insecurity are: i) seasonal or cyclical food insecurity, which happens just before the harvest when food supplies are limited and prices are high; ii) transitory food insecurity (acute) refers to short periods of extreme food insecurity, which are often a result of more unpredictable and sudden events, such as climatic shocks, natural disasters or economic shocks; and iii) chronic food insecurity (moderate) refers to long-term shortage and is closely linked to chronic poverty, lack of assets, and structural deficiencies in the local food systems in the economy (Stats-SA, 2012). Achieving food security requires households to have adequate resources to obtain appropriate foods for a nutritious diet.

2.3   Livelihood, poverty and food security

Livelihood strategies are subject to the behavior and choices adopted by people to make a living, for example, how people access food, earn an income, allocate expenditures, labor, land and resources, manage assets and respond to shocks such as floods, cyclones, droughts, disruptions of food assistance and market price changes (DFID, 1999). These lifestyle choices or strategies are influenced by the assets or capital available to households that include human, social (political, cultural, and psychological), natural and financial resources. The concept of livelihoods, therefore, broadens the understanding of food security beyond just the availability of food and instead considers all capabilities, assets and activities required to live (Stats-SA, 2012). Livelihoods are secure and sustainable when households have secure ownership of, and access to resources and income-earning activities to cope and recover from stresses and shocks, while not undermining the future natural resource base (DFID, 1999). The areas that show homogenous ecological and economic features may be referred to as 'livelihood zones', though rich and poor households in the same livelihood zone may use local resources in varying degrees (FEWSNET, 2012). For example, people living in a fertile highland area have very different livelihood options to those living in a semi-arid lowland area. The livelihood zones in Botswana are central-southern mixed open-access livestock and

upland crops, exclusive livestock, upland crops and nonfarm income (Rethman and Muhangi, 2009); in Mozambique, the livelihood zones are upper Limpopo Riverine-Massingir, semi-arid interior-maize, sorghum and millet, Upper Limpopo riverine Chicualacuala/Mabalane, Upper Limpopo interior-agricultural and charcoal, coastal Inhambane and Gaza, and Lower Limpopo Alta-maize (FEWSNET, 2012); in South Africa, the livelihood zones are livestock and rain-fed mixed crop/livestock systems in arid to semi-arid areas (Thornton et al., 2006); and, in Zimbabwe, they are characterized by rain-fed maize and other small grain crops, livestock and various non-farm income generating activities, including beer brewing and small-scale gold panning in the rivers (Southern Africa Livelihood Zones Database, 2013).

Livelihood zone boundaries do not always closely follow the administrative boundaries (Lawrence et al., 2006), making it very difficult to link information gathered from the livelihood zones to decision making. Livelihood analysis is used as a basis for designing and planning interventions, ranging from emergency response to disaster mitigation to longer-term development, including agriculture. In a basin or country, livelihood zone maps provide a quick grasp or comparison of food security conditions and a full account of how people adapt or cope with certain crises to enable decision makers to provide informed and appropriate responses to these crises (ZimVac, 2013). Food insecurity challenges faced in the Limpopo Basin include high levels of poverty, unemployment, inadequate safety nets, and unstable household food production due to erratic rainfall. Food security is an outcome of the livelihood strategies adopted by households, while poverty levels shape the livelihood strategies.

2.4   Why poverty maps?

The importance of poverty reduction as a part of the Millennium Development Agenda has motivated greater interest in the geographic dimensions of poverty, natural resources availability and food security (Szonyi et al., 2010). Mapping can help in assessing 'hot spots' for engagements with certain issues, (i.e., targeting poor areas) and can provide information on biophysical and sometimes social characteristics that affect opportunities and constraints in development. The spatial distribution of poverty is of interest to policymakers and researchers, as it can be used to quantify disparities in welfare across regions and to facilitate the targeting of programs that alleviate food insecurity and poverty (Szonyi et al., 2010). These programs include, among others, agricultural water management (AWM) interventions.

Furthermore, poverty and food insecurity maps that highlight areas marginalized by resource constraints help in setting priorities for developing technologies and in deploying resources to where they are most needed and likely to make the most effective impact on alleviating poverty (Szonyi et al., 2010). By identifying who and where the poor are, poverty maps may also help to target research efforts for rapid and cost-effective policy formulation and solutions. Mapping also provides a crucial visualization that supports transparent negotiations among interested parties and groups, including neighboring communities and states.

3: Methods and data

The data and maps presented here from 2003–2013 on poverty and food insecurity are from a combination of census, food security, and income and expenditure surveys from the four countries in the Limpopo River Basin (LBFP, 2010) and other published sources (FEWSNET, 2011, 2012; Trade Mark South Africa, 2011; RBCSO, 2008; Stats-SA, 2006, 2008; MPSLS, 2003). Each of these surveys from the four countries had minor differences, such as the length and detail of its questionnaire, the sample size, and the methodology used to process the data. Hence, the 'Small Area Income and Poverty Estimates Method' (Elbers et al., 2003) that uses data from a variety of sources, to create statistical models to produce income and poverty estimates was used for districts that wholly and or partly lie in the basin. Monetary and food poverty (which strongly reflects food security interests) were used to present the proportion of a given population falling below the poverty threshold in the basin countries. The constructed maps were then overlaid against CPWF Phase II LBDC study sites, smallholder subsistence farms (Andersson et al., 2013) and AWM intervention case study sites from L1 stakeholder consultations in early 2011. The L1 2-day consultation workshops were carried out in both South Africa and Zimbabwe, with the participation of stakeholders from the private sector, universities, researchers, local farmers, water catchment councils, nongovernmental organizations, and water and agriculture ministries in the four basin countries. During these workshops, stakeholders presented examples of past and on-going AWM intervention cases in their respective areas. These consultations were followed by a comprehensive data collection of successful AWM interventions at community level through 1-day focus group workshops (Sieber, 2006). Each workshop involved a maximum of fifteen farmers who had experiences with AWM interventions for more than 2 years. The Participatory Geographical Information System (PGIS) methodology was used to collect local data (Dunn, 2007; Sieber, 2006) and applied in various contexts, (e.g., de Bruin et al., 2012a, b). This method involved collecting and mapping information at the community level to identify what social, economic, bio-physical and organizational factors are critical for the successful adoption and proliferation of different AWM interventions among smallholder farmers. The different data sets provided were superimposed to ascertain whether the study sites from L1 stakeholder consultations, PGIS workshops and LBDC are in the principal target areas of the Limpopo River Basin in terms of the basin challenge of poverty and food insecurity reduction of smallholder farmers. Specific food insecurity and poverty surveys for each basin country are presented next.

Botswana

The surveys used in Botswana were at district and sub-district levels and included the 2001 Population and Housing Census along with the in-depth poverty analysis from the 2002/2003 Household Income and Expenditure Survey (HIES) published in the Botswana Poverty Datum Line Report (RBCSO, 2008). The 2001 Census Database produced close to 1.7 million individuals grouped into approximately 405,000 households (RBCSO, 2008). Furthermore, the Census grouped households into approximately 4,150 'Enumeration Areas' (EAs) of about 97 households each, on average (RBCSO, 2008). The 2003 poverty review used five categories of consumer goods comprising 123 items (Trade Mark South Africa, 2011). According to Trade Mark South Africa (2011), a study in 2002 suggested a family of four could subsist (poverty datum line) on BWP 571.65/month (US$ 75/month). Rural poverty levels of US$1/ day per person and US$1.25/day per person were used for 2003 and 2009/2010 periods, respectively, based on a methodology that incorporates information on household expenditure developed by Elbers et al., (2003) that involved two parts. The first part was extracted from the Census and HIES data and established linkages between the two data sets; the second part used poverty datum line estimates to derive the district and sub-district poverty levels.

In Botswana, income poverty was measured in 10 districts and sub-district levels, using the Statistics Botswana Poverty Datum Line (PDL), which represents the value of a basket of five broad categories of consumer goods such as food, clothing, personal items, household goods, and housing (Maundeni and

Nnyepi, 2011). The daily/monthly requirements for PDL basket components differ according to sex, age and consequently the household composition. The cost of this basket was then compared with the observed total consumption for the household, which is calculated by adding up the total consumption expenditure, aid, wages in-kind, gifts received, school meals and unearned income in-kind. When a household's PDL is lower than its observed total consumption, the household is defined as poor. In 2009/2010, the cost of the food component of the PDL was an average of BWP 680.02 (US$95.61) compared with BWP 445.51 (US$91.24) in 2002/2003, making the food component the largest contributor to the overall average household's PDLs of BWP 878.87 (US$123.57) in 2009/2010 and BWP 571.65 (US$117.07) in 2002/2003 (Botswana Central Statistics Office, 2011).

Mozambique

There are 14 districts in the part of the Limpopo Basin that is in Mozambique. Poverty data sources included the Surveys of Household Groups (SHGs) in 2002/2003 and 2008/2009, which is conducted once in every 5 years, and the Welfare Indicators Questionnaire (WIQ) completed in the interim between SHGs in order to provide annual estimates of income and expenditure of household groups and other socioeconomic characteristics (Mozambique Poverty Reduction Vision, 2001). These household surveys are conducted over a 12-month period, so as to capture the seasonal variability. The 2002/2003 and 2008/2009 SHGs, at the national, provincial, urban and rural levels were conducted using a self-weighted, multi-stage sample, and each survey covered an estimated 8,289 household groups residing in 182 blocks in the provincial capitals, including the City of Maputo, and in 671 villages in the rest of the country (LBFP, 2010).

The 2002-2003 survey used a poverty line of US$1/day per person, while the 2008-2009 survey used US$1.25/day per person, which are common international poverty benchmarks (Sachs, 2005). These poverty levels were estimated based on calorie content of the local food basket and the local prices paid for the food items (van den Boom, 2011), while food insecurity was based on a 30-day recall from the rural population of the number of times food shortage was experienced. Data from the surveys on household food consumption such as the variety and frequency of different foods consumed over a 7-day recall period, as an indicator of dietary diversity, which is a good proxy of food security at household level, were also collected (FEWSNET, 2013; van den Boom, 2011). Food items considered in the computation of the food consumption score (FCS) from the SHGs included milk, meat, pulses-cereals, peanuts/cashews, watermelon, tomatoes/onions and wild food. These food items were analyzed separately (item by item) and then combined into an indicator (FCS) that takes into account the frequency, diversity and the nutritional value of the food groups consumed. With the computed FCS, two thresholds (21 and 35) were used to distinguish consumption levels. Households were categorized as poor consumption (FCS ≤ 21); as borderline consumption (21< FCS ≤ 35); and as acceptable consumption (FCS > 35).

South Africa

The South African portion of the Limpopo Basin has 13 district councils, which are subdivided into more than 75 local districts. The 2003 poverty data used for mapping was taken from a household survey conducted by the Community Agency for Social Enquiry (CASE) in 2003 and consisted of over 6,000 people in 60 poor communities (LBFP, 2010; UN-HABITAT/UNEP, 2007; IWMI, 2003), while poverty data for 2007 and 2010 was obtained from General Household Surveys for the respective years. The 2003 poverty profile was based on a poverty line of ZAR 8 (US$1.14)/day per person (Stats-SA, 2003), while the income poverty line was about ZAR 1,100 (US$157) per average family per month (Stats-SA, 2004). While the government provided free or subsidized services, such as electricity, water, schooling, health care and housing to many poor people (Stats-SA, 2004), a large proportion of the population had an income less than ZAR 1,100 (US$157) per month. All these free or subsidized services were equal to about ZAR 1,100 (US$157) per family per month (Stats-SA, 2004, 2006). The 2007 and 2010 poverty profiles were based on the international poverty line (that included food and non-food items) of US$1.25/day per person (Stats-SA, 2012). Nationally, South Africa used a food poverty line of ZAR 305 (US$33)

per person per month in March 2009, which is the amount of money that an individual utilized to have the required energy intake, while the international poverty line was ZAR 416 (US$45) per capita per month at that time (March 2009) as it took into account nonfood items of households as well (Stats-SA, 2012). Food insecurity assessments in relation to hunger were derived from surveys based on experiences among adults and children in households during the previous 12 months, to establish how limited food might have influenced changes in their diets or food consumption patterns. Hunger results from lack of food entitlement and deprivations in related essential services of healthcare, education, safe drinking water, and adequate sanitation; and its conventional measure reflects persons consuming less than 1,960 calories per day according to Statistics South Africa (2004). The access to food groups, changes in diet or consumption of food during the previous 30 days, as self-reported by households, were noted. Food groups considered in the survey were cereals (maize, rice, sorghum, millet and bread), tubers (potatoes, sweet potatoes and cassava), legumes (beans, peas, groundnuts and cashew nuts), vegetables, fruit, animal products (beef, goat, poultry, pork, fish and eggs), milk, yoghurt and other dairy products, sugar and sugar products, oils, fat and butter. The scores used in the surveys were: zero if the event described by the question never occurred; one point if it occurred; and another point if it occurred 5 or more days during the previous 30 days. For each household the score corresponded to the sum of these points and ranged from 0 to 8, with adequate access to food (score 0–1); inadequate access to food (score 2–5); and severe inadequate access to food (score 6–8) – (Stats-SA, 2012).

Zimbabwe

There are 11 districts in the part of the Limpopo Basin that is in Zimbabwe. The Government of Zimbabwe is involved in several large-scale data collection activities that include an Income, Consumption and Expenditure Survey (conducted once in every 5 years), Demographic and Health Surveys, the Population Census, and Food Security Surveys (MPSLS, 2003). The Income, Consumption and Expenditure Survey data were used in poverty assessment, while the Food Security Surveys were used to identify the proportion of the population that was food insecure (LBFP, 2010). In 2003, the percentage of the population that could not meet basic food requirements and lived on less than US$1/day per person was categorized as poor (MPSLS, 2003), while households with incomes below the 'Total Consumption Line' (TCL) were considered to be poor in 2011. However, the 2003 poverty levels in different districts could have been affected by the successive droughts from 2000 to 2003 (LBFP, 2010), as the main source of consumption came from purchases, with agricultural production being marginal.

Household food security status was determined by comparing its estimated food entitlements to its food requirements (ZimVac, 2011a). Household food entitlements (measured in maize equivalence) were computed from summing up cereal stocks, own food crop production, potential income from own cash crop production, potential income from livestock, and income from other sources such as gifts, remittances, casual labor, pensions and formal employment. Household requirement (measured in maize equivalence) is a product of household size and per capita cereal requirements of 133 kg/annum (ZimVac, 2011a). According to this survey, when a household's food entitlements are equal or greater than household requirements, that household was considered to be food secure. In addition, food-insecure persons were considered as those unable to meet their daily minimum energy requirements of 2,100 Kcals (of which 70% is from cereals) at all times (ZimVAC, 2006). This minimum energy requirement was also referred to as 'Food Poverty Datum Line' (FPDL). Food stuffs considered were cereals (maize, sorghum and millet), animal protein, fruit, leafy vegetables, milk, sugar, cooking oil, nuts and pulses, and wild foods. Cereals, followed by leafy vegetables were reported to be the most consumed type of foods by both the food secure and insecure households (ZimVAC, 2006). According to ZimVac (2011b), an individual whose total consumption expenditure does not exceed the food poverty line is deemed to be very poor. The sum of the FPDL and minimum acceptable expenditure on essential non-food household goods and services determines the 'Total Consumption Line' (TCL). Households with incomes below the TCL were considered to be poor.

4. Population and poverty in the Limpopo River Basin countries

The physical and socioeconomic conditions of the four Limpopo Basin countries are shown in Table 1. The basin population densities in Botswana and Zimbabwe are higher than their respective national densities. There is, generally, an increase in average basin population density over the years, (e.g., from six people/km² in 1960 to twelve people/km² in 2000), especially in the delta areas of Zimbabwe and Mozambique (http://www.na.unep.net/datasets/datalist.php3). This increase in population density puts extra pressure on natural resources and, as such, they should be prudently managed.

The common measures of monetary and food poverty (which strongly reflects food security interests) used by the basin countries were the income and/or consumption poverty lines that vary according to a country's economic and social circumstances. These measures are usually directly related to a lack of assets, income, endowments, and capital, e.g., people being unable to satisfy minimum required expenditures on food, housing, health, education, energy, and transport. The population and poverty lines used in the four countries linked to the Limpopo River Basin are shown in Table 2. The comparison of the national and basin portion poverty levels shows that the poverty incidence in the basin is significantly higher than that at national levels, except for Botswana (Table 2).

Table 1: Physical and socioeconomic features of the four Limpopo Basin countries

Physical	Botswana	Mozambique	South Africa	Zimbabwe
Country total area (km²)	581 730	801 590	1 221 040	390 760
Area of country within basin (km²)	80 118	84 981	185 298	62 541
Area in basin as % of country	14	11	15	16
Country area in basin as % of whole basin	19	19	45	15
Socioeconomic				
Population in 2011 (million)	2.03	23.93	50.59	12.75
National population density (people/km²)	12.7 (2004)	21 (2004)	40.2 (2009)	22 (2004)
Basin population density (people/km²)	15 (2007)	18 (2007)	43 (2008)	8 (2007)
Rural population % in country (1998) 2011	(31) 38	(62) 69	(50) 38	(66) 61
Income level (2011)	Upper middle	Low	Upper middle	Low
GNI per capita in 2011 (US$)	7 470	460	6 960	660
Mortality rate under 5yrs per 1,000 births (2011)	26	103	47	67
Life expectancy at birth in 2011 (years)	53	50	53	51
School enrolment, primary in 2011 (%)	106	111	102	103
Literacy rate, adult total (%)	84 (2010)	56 (2010)	88 (2011)	92 (2010)

Sources: (World Bank, 2011, 2013; Sullivan and Sibanda, 2010; UNDP, 2003)
Note: GNI=Gross National Income using Atlas method (currency US$); Literacy rate, adult total is the % of people aged 15 and above. The average population density in the Limpopo province is 40 persons/km² in South Africa (FAO, 2004b), but very high in former homelands

4.1 Botswana rural poverty and food insecurity mapping

The survey results showed that Botswana (nationally) had one of the highest percentages of female-headed households (more than 46%), a statistic that is the highest in the world. On an average basis, female-headed households are considered poorer than their male counterparts (RBCSO, 2008). This fact is clearly illustrated in Botswana where 34% of the female-headed households are below the poverty line compared to only 27% of the male-headed households (RBCSO, 2008). Furthermore, the Gini co-efficient used to assess inequality in Botswana is worse than that of South Africa (Sullivan, 2002). Rural poverty distributions at district level are shown in Figures 2a and 2b, and Table 3, while food insecurity distributions are shown in Figures 3a and 3b for the Limpopo basin part in Botswana. Given that the focus is on rural poverty, the main 'urban centers' poverty levels including Selibe Phikwe, Lobatse, Francistown and Gaborone (capital city) are not shown in Figures 2a and 2b, but in Table 3.

Table 2: Population and poverty levels in the Limpopo River Basin countries

Country	Limpopo Basin population in 2007 (million) (LBPTC, 2010)	Poverty line 2003 (after 2007) (cap/day)	National (rural and urban) poor population in 2003 (%)	Rural population in basin in 2003 (million) (FAO, 2004b)	Rural population below poverty line in basin in 2003 (after 2007) (million)
Botswana	1.21	< US$1.25 (US$1.25)	33.3	0.835	0.32 (**0.25)
Mozambique	1.39	US$1 (US$1.25)	37.9	1.05	0.76 (*0.58)
South Africa	10.7	US$1 (US$1.25)	11.5	5.40	3.67 (*3.64)
Zimbabwe	1.14	US$1 and Insufficient basic food and non-food needs (TCS)	36	0.90	0.67 (*0.49)

Notes: TCS= total consumption score of food and non-food basic needs (ZimVac, 2011a, 2011b); **values obtained from rural head count data in 2007 (RBCSO, 2008).* Estimated values calculated using percentage of rural population in 1998 from Table 1, assuming country rural proportions applies to Limpopo Basin (LBFP, 2010)

Table 3: Population, area and percentage of poor by district in the Limpopo River Basin, Botswana

District	Area of district (km²)	District population 2001 (2011)	Poverty level (%) in district 2003 (2009/2010)
Central District	*146 374	453 324 (521 367)	48 (20.9)
North East District	5 146	49 399 (59 829)	30 (17.7)
Francistown City	200	83 023 (100 079)	14.1 (18)
Selibe Phikwe Town	142	49 849 (49 724)	15.7 (12.8)
Kweneng District	36 963	230 335 (304 674)	46 (39.3)
Kgatleng District	7 619	73 507 (92 247)	33 (18.4)
Southern District	27 233	113 704 (129 462)	46 (20.6)
Gaborone City	197	186 007 (227 333)	6.5 (12.4)
South East District	284	60 623 (92 843)	24 (19.6)
Lobatse Town	122	29 689 (29 032)	19.1 (17.8)
Total/Average	224 280	1 329 460 (1 606 590)	28.2 (19.8)

Note: The district partly lies outside the Limpopo River Basin. Number of people in each district in 2001 (Source: IIASA, 2001). National population density of Botswana was 12.7 persons/km² and rural population of 54.3% (FAO, 2004b).

Figure 2: Botswana rural poverty maps at district level in 2003 (a) and 2009/2010 (b)
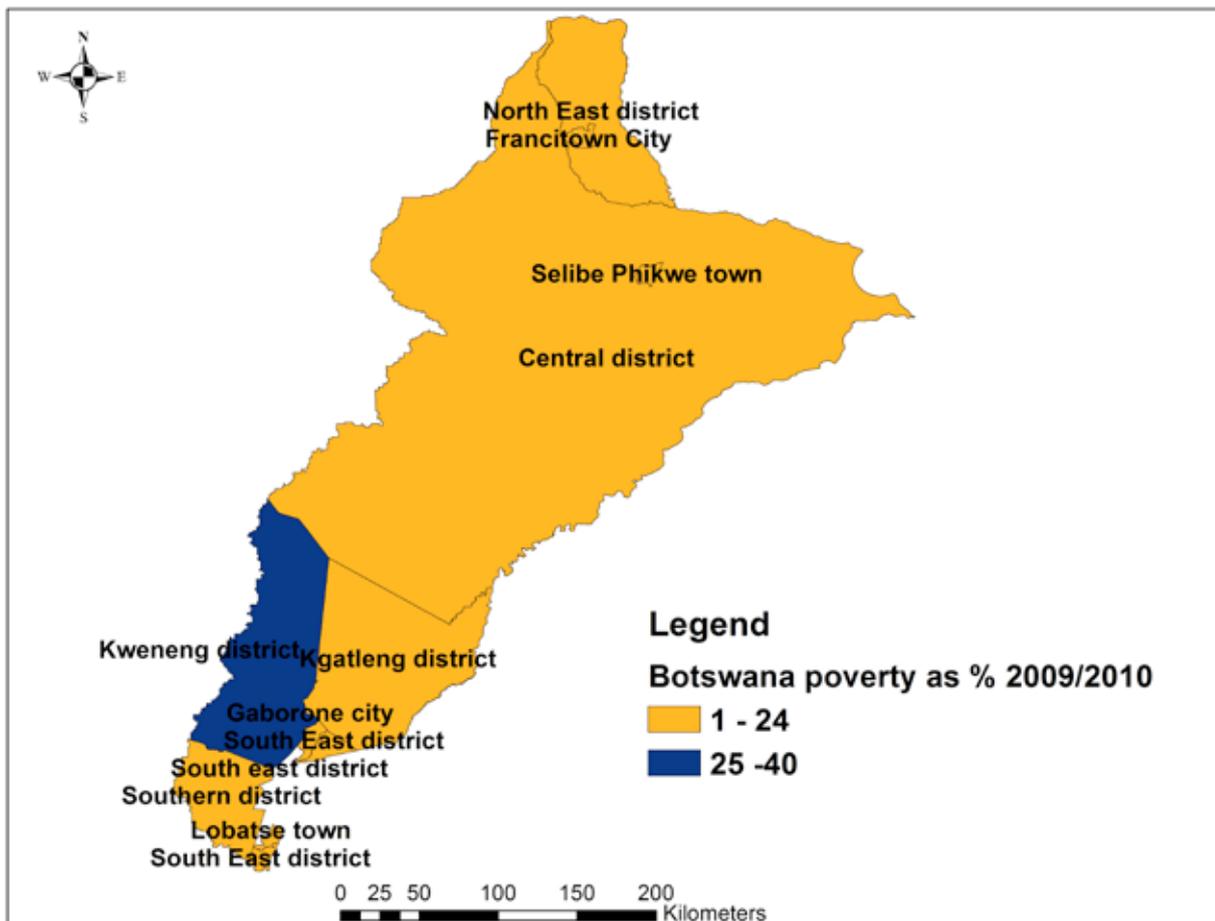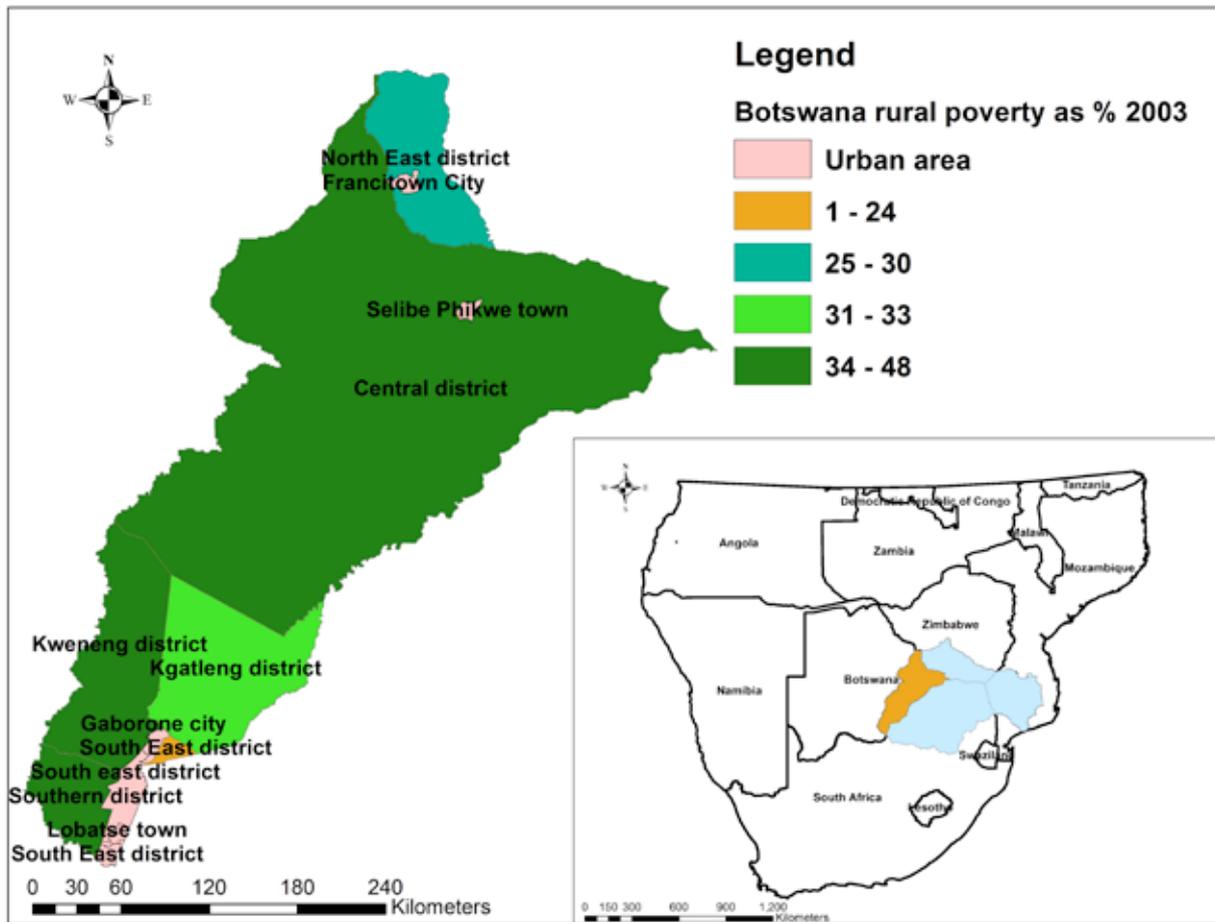
Figure 3: Botswana rural food insecurity maps at district level in 2003 (a) and 2009 (b)
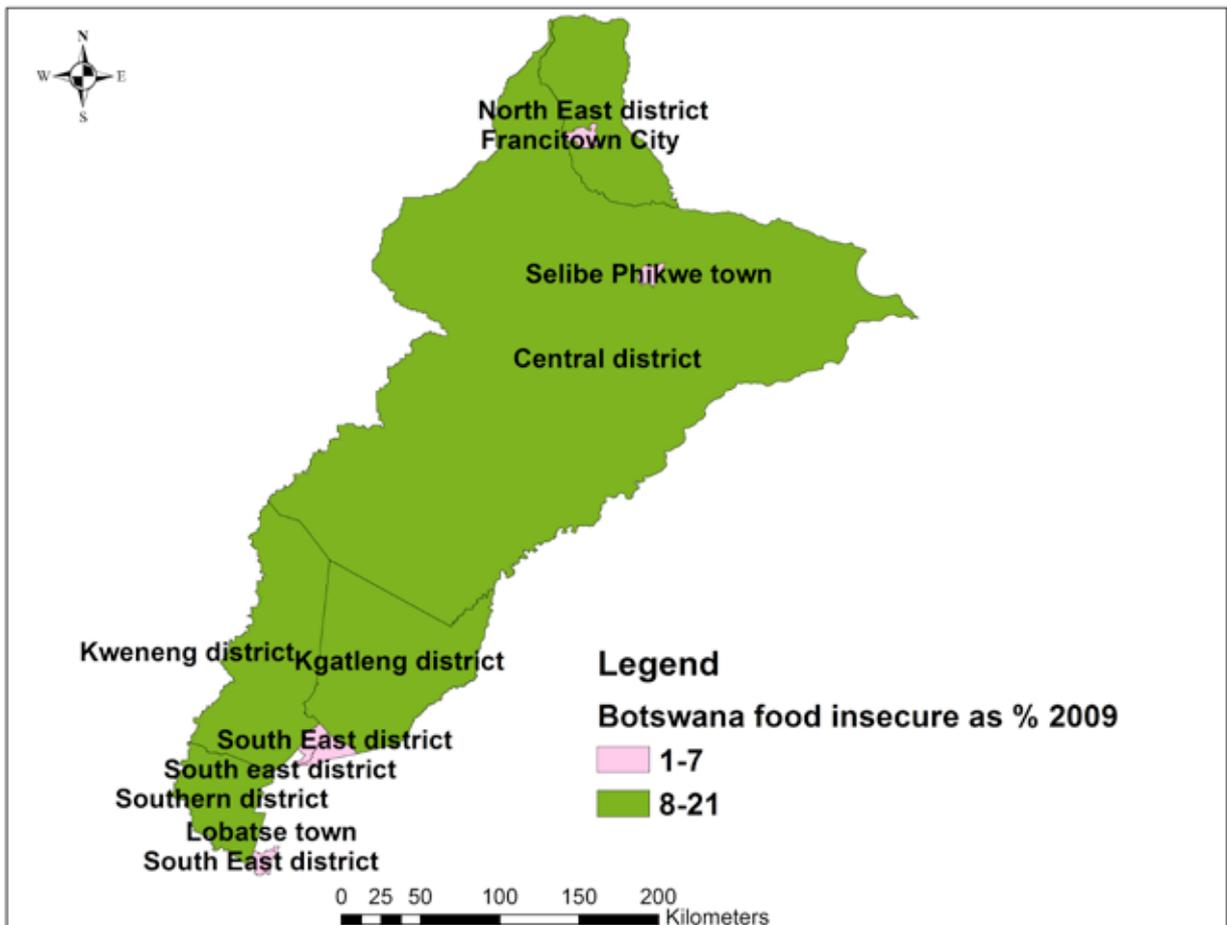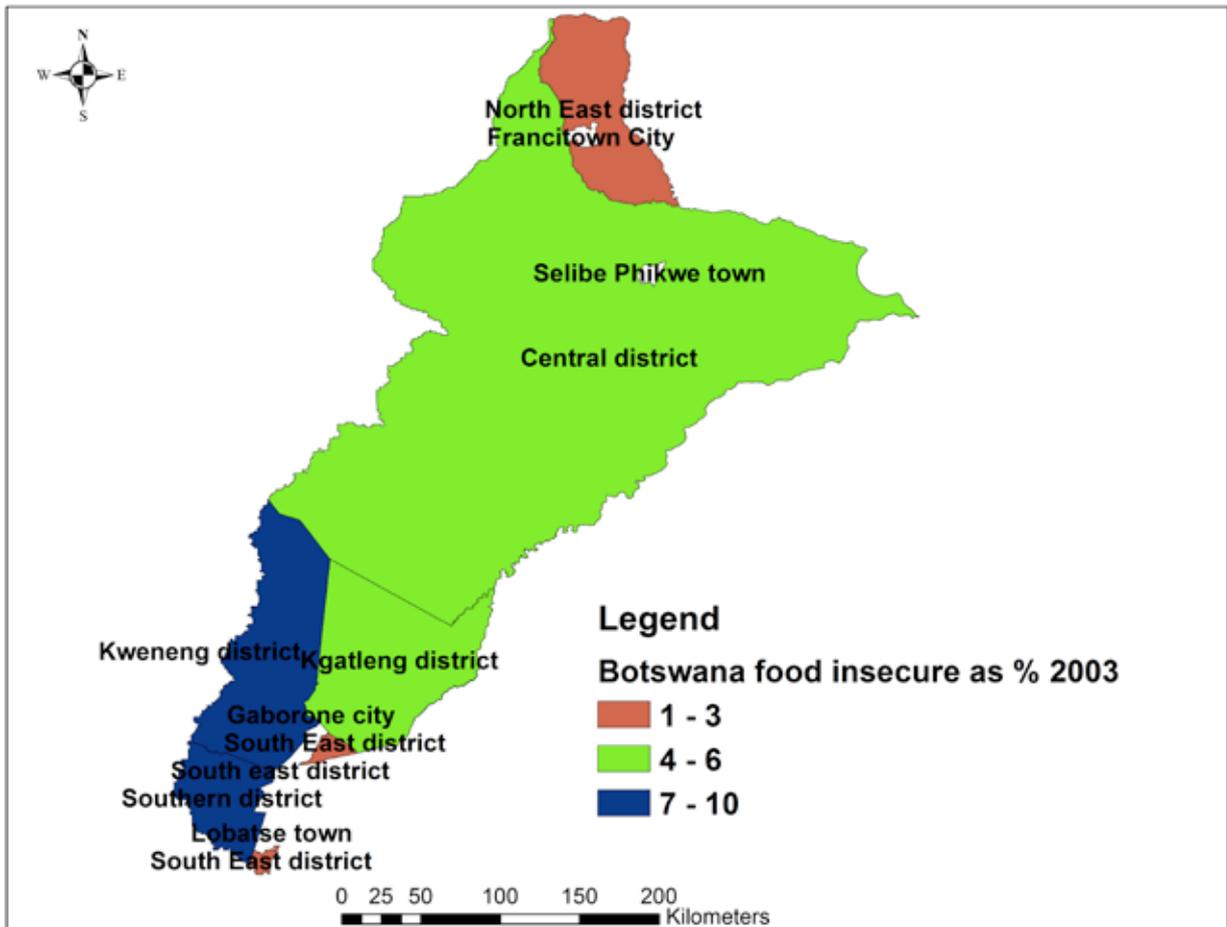
4.1.1 Efforts to reduce poverty and food insecurity in Botswana

Following the implementation of the 1997 National Development Plan 8 (NDP 8), the Botswana economy has been transformed from one based on cattle rearing and subsistence agriculture to one of rapid economic growth, which is based on exploitation of minerals and investment of these revenues in economic and social infrastructure developments (LBFP, 2010; BIDPA, 1997). The National Development Plan 9 (NDP 9, 2003–2009), comprised economic diversification, employment creation, and poverty reduction; continued macroeconomic stability and financial discipline; public sector reforms; environmental protection and rural development; human resource development, including the fight against HIV and AIDS; and disaster management (LBFP, 2010; Siphambe, 2003). However, the main features of the Rural Area Development Plan included the promotion of both farm and off-farm income earning opportunities, giving priority to water conservation and management efficiency, ideals which are well aligned with the CPWF Phase II LBDC (http://sites.google.com/site/cpwfbdceoi), and the development of a rural labor public works program by the Botswana Government (LBFP, 2010).

Targeted relief programs were established for those not benefiting from the expansion of the rural economy (Siphambe, 2003). Among these development policies were schemes that reduce poverty through employment creation, such as Financial Assistance Policy (FAP), Small Micro and Medium Enterprises (SMMEs), and the Citizen Entrepreneurial Development Agency (CEDA) – (Siphambe, 2003). The government programs included: i) Labor Based Public Works Program, ii) Labor Intensive Public Works Program, iii) Accelerated Rain-fed Arable Program (ARAP), iv) Remote Area Development Program (RADP), and v) Arable Lands Development Program (ALDEP). Some of these programs, in particular, the ARAP and the RADP, are also well aligned to the goals of the CWPF Phase II LBDC program. At the district level, informal business activities and vending are major sources of income for the majority of the unemployed population in the part of the Limpopo River Basin, which is in Botswana (LBFP, 2010). Another area of development was the government and NGO safety nets, to support orphans and the disabled, a pension scheme for old aged persons, and the drought relief program that was set up to help the destitute (Siphambe, 2003). Siphambe (2003) reported that the safety net programs have been highly criticized for creating a culture of dependency, as most of these programs are not well targeted and, therefore, are subject to abuse and fraud. Elsewhere, Booysen et al. (2005) praised safety net programs in Brazil, claiming that with only 10% of government spending (Grosh, 2009) the programs enabled Brazilians to move out of the poverty status they were in.

4.2   Mozambique rural poverty and food insecurity mapping

The livelihood zoning exercises (based on land size and oxen ownership) carried out by FEWSNET (2011) in February 2010, showed that in Chicualacuala the poor and very poor constitute about 72% of the population, while in Massingir the poor and very poor constitute about 73% of the population. Though limited in scope, the livelihood zoning results compare well with the district poverty levels obtained from the 2003 and 2008/2009 household surveys in Mozambique presented in Figures 4a and 4b and Table 4, suggesting that the district poverty levels and consequently the welfare of the population had not significantly changed over the past years. According to FAO (2004b), the rural population in the basin was estimated at 1.045 million people in 2001, while from the total population of 1.2 million people in 2007 in the basin part of Mozambique, over 66.4% were classified as poor (Table 4). Poor households, mainly the elderly living with orphans, widows and female-headed ones, have limited labor and livelihood opportunities. The proportion of households considered at high risk of food insecurity shown in Figures 5a and 5b shared the following characteristics: a limited number of plots of land, predominantly in upland areas; less access to formal or informal credit facilities; limited remittances or transfers of funds; frequent use of extreme coping strategies to manage risks, such as foregoing meals; poor consumption patterns and very poor quality of diet (FEWSNET, 2004).

Table 4: Population, area and percentage of poor by district in the Limpopo River Basin, Mozambique

District	Area of district (km²)	District population 2007 (2012)	Poverty level (%) in district 2003 (2008/2009)
Chibuto District	5 772	191 682 (207 210)	51 (65)
Chicualacuala District	17 676	38 917 (42 542)	91 (50)
Chigubo District	15 872	20 725 (25 803)	95 (>80)
Chokwe District	1 803	183 531 (196 671)	64 (60)
Funhalouro District	10 461	37 856 (44 320)	94 (50)
Guija District	5 411	75 306 (86 567)	50 (70)
Mabalane District	7 936	32 067 (36 121)	72 (70)
Mabote District	6 854	44 733 (49 867)	89 (>80)
Manjacaze District	721	165 071 (175 607)	57 (75)
Massangena District	5 411	15 780 (17 287)	71(>80)
Massinga District	721	186 292 (199 156)	82 (50)
Massingir District	5 411	28 701 (–)	83 (>80)
Panda District	1 443	47 799 (51 317)	90 (70)
Xai–xai (Town)	1 804	115 752 (124 216)	56 (50)
Total/Average	**81 164**	**1 184 212 (1 256 684)**	**74.6 (66.4)**

Note: Source of district population from Census (2007): http://www.statoids.com/ymz.html; http://www.geohive.com/cntry/mozambique.aspx (Accessed 14 May 2013). The districts in the Limpopo River Basin fall in Gaza Province in Mozambique, with population of 1.25 million; area of approximately 81 000 km² containing Xai-Xai Town. The basin-wide average population density in Mozambique of 15.4 persons/km² in 2012 is lower than that of 18 persons/km² reported in 2007 (Table 1). The national population density from Table 1 was 21 persons/km² in 2004 (FAO, 2004b; IIASA, 2001).

4.2.1 Efforts to reduce poverty and food insecurity in Mozambique

The Government of Mozambique has implemented a number of development policies aimed at reducing poverty, including the National Program for Agricultural Development (PROAGRI). This is a program aimed at transforming the subsistence agriculture sector to produce a surplus for the market, and to develop an active and efficient entrepreneurial sector for the development of agriculture (Mozambique Poverty Reduction Vision, 2001; Bolnick, 2000). The PROAGRI provides, for the majority of the rural households, the means to reduce poverty and food insecurity. These aims are in line with the LBDC (http://sites.google.com/site/cpwfbdceoi). The Plan for the Reduction of Absolute Poverty (PRAP) aimed to reduce the incidence of absolute poverty from 54% in 2003 to 45% in 2009 through pragmatic actions in agriculture (also in line with the LBDC), health, education and rural development (Bolnick, 2000). Furthermore, a complementary 'Agricultural Marketing Strategy' was developed for 2006–2009 period with the objective of stimulating efficiency by improving agricultural marketing, inputs and agricultural services for all stakeholders (LBFP, 2010). The Water Act (Water Law Resolution No. 7/95 in 1995) established basic principles of improved management of available water resources for all purposes, including agricultural water use (Limpopo River Awareness Kit, 2011), which aligns with the LBDC aims, focusing on smallholder farmers (http://sites.google.com/site/cpwfbdceoi).

Figure 4: Mozambique rural poverty maps at district level in 2003 (a) and 2008/2009 (b)
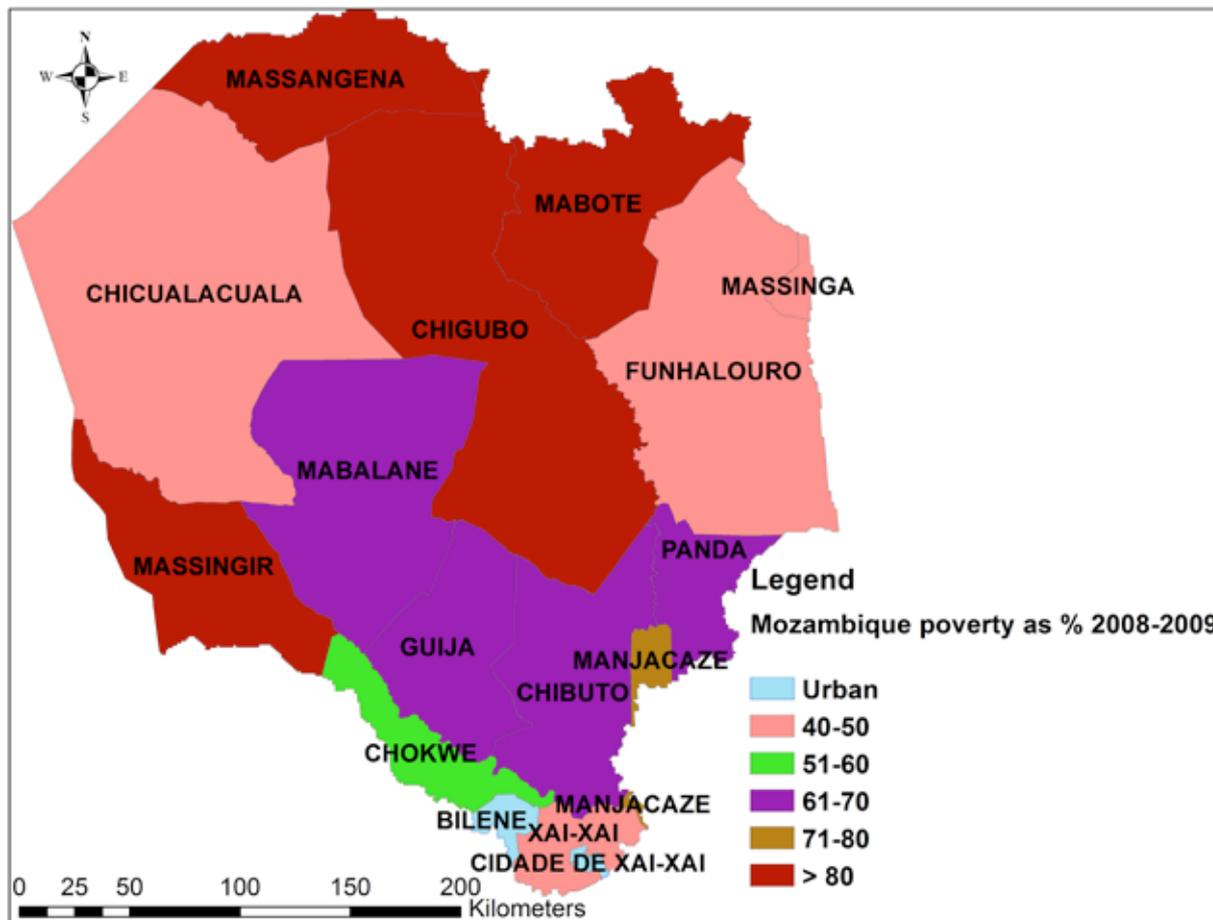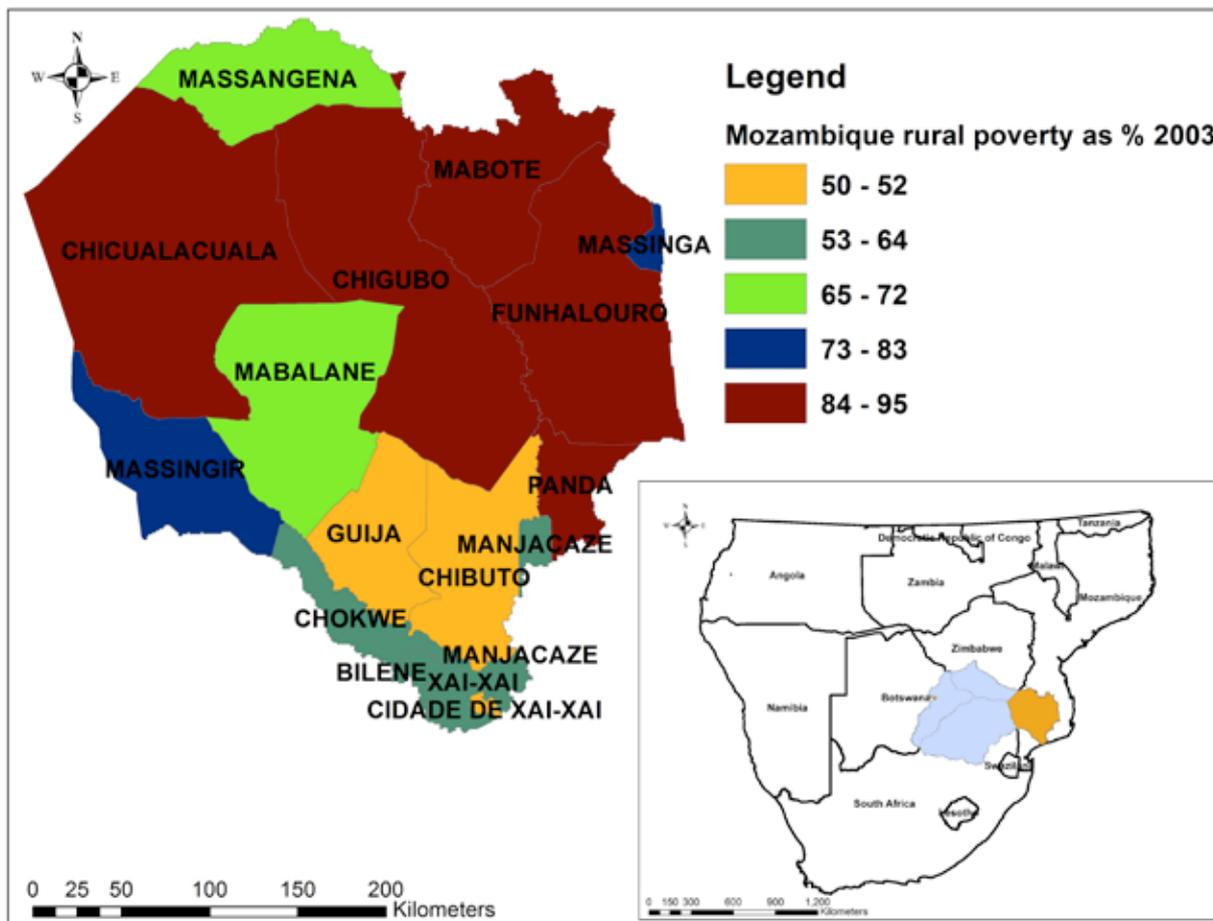
Figure 5: Mozambique rural food insecurity maps at district level in 2003 (a) and 2008 (b)
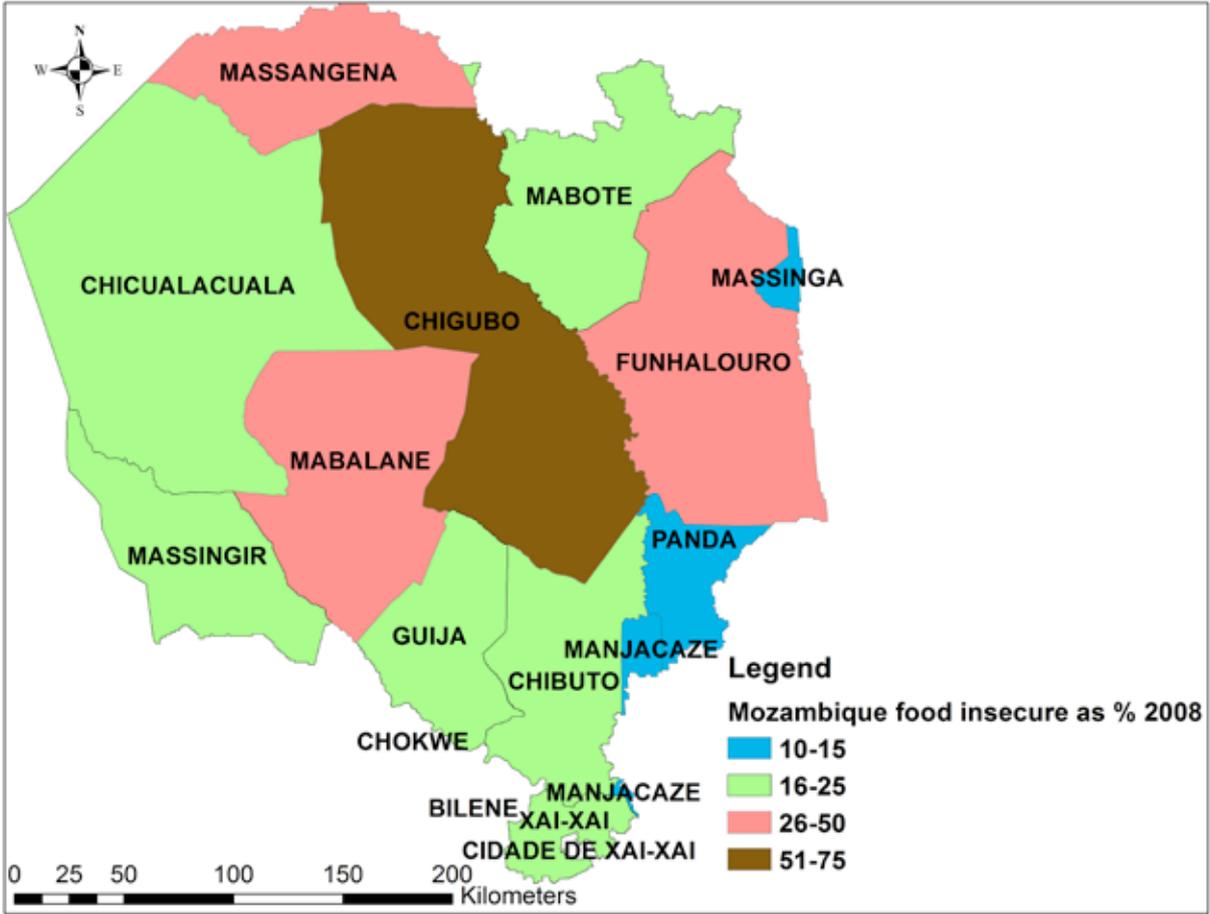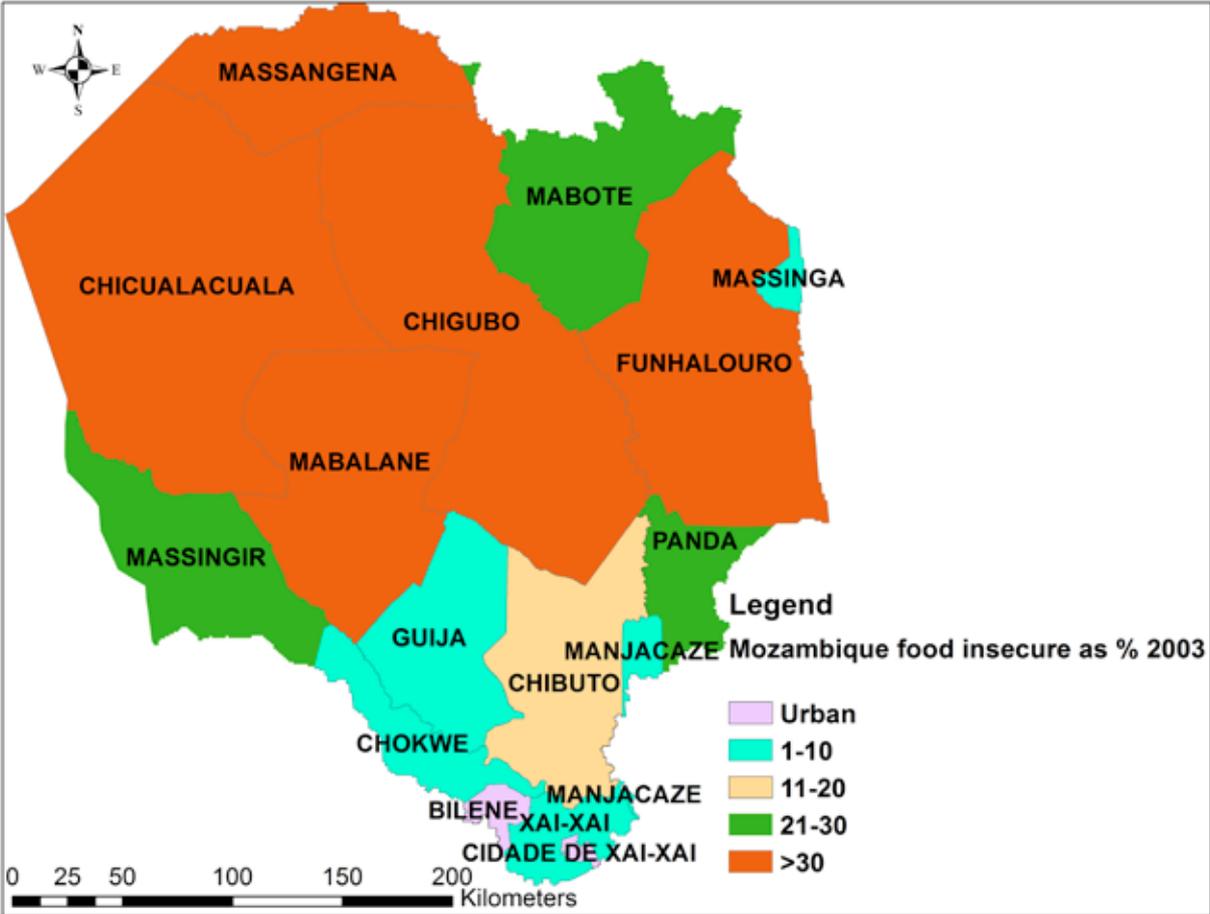
4.3   South Africa rural poverty and food insecurity mapping

South Africa is ranked among the most unequal societies in the world – the poorest half of all South Africans earn 9.7% of the national income, whilst the richest 20% take 65% of all income (DBSA, 2011; Stats-SA, 2006; PROVIDE, 2005; Stats-SA, 2004). The percentage distributions of head count of persons below the poverty line at district level for 2003, 2007 and 2010 are shown in Figures 6a, 6b and 6c, respectively, while those who are food insecure at the district level are shown in Figures 7a-c, in the part of the Limpopo Basin that is in South Africa. The population and poverty levels for 13 district councils in South Africa are shown in Table 5 for ease of presentation, as there are more than 75 local districts within the district councils (Stats-SA, 2006). The greater Sekhukhune District ranks the highest (shown by red color key in Figures 6a and 6c, and brown color key in Figure 6b and Table 5) in terms of poverty, with about 70% of the population in both 2007 and 2010 living below the poverty line (Figures 6b and 6c). The most poverty affected groups are female-headed households, the disabled and child-headed households (Stats-SA, 2006). On average, the basin poverty level increased from 51.8% (2007) to 56.1% (2010). This increase could be attributed to the global recession.

The population density in the part of the Limpopo Basin that is in South Africa was 43 people/km^2 in 2008 (Table 1), which was higher than the average of 37 people/km^2 for the whole of South Africa (Stats-SA, 2006). Approximately 87% of people in the South African part of the basin live in rural areas (PROVIDE, 2005), while about 10.7% lived in urban areas in 2001 (Stats-SA, 2004). The rural population in the basin was estimated at 5.4 million people in 2001 (FAO, 2004b).

Table 5: Population, area and percentage of poor by district in the Limpopo River Basin, South Africa

| District council	Area of district (km²)	District population 2007 (2011)	Poverty level (%) in district 2007 (2010)
Sekhukhune District	13 528	1 090424 (1 076 839)	70.6 (69.5)
Mopani District	20 011	1 068568 (1 092 507)	65.1 (64.6)
Vembe District	25 597	1 240035 (1 294 722)	60.3 (60.7)
Capricon District	21 705	1 243167 (1 261 461)	64.6 (63.9)
Waterberg District	44 913	596 092 (679 335)	41.0 (43.3)
Part of Ehlanzeni–Nelspruit District	15 969	600 463 (693 634)	40.0 (47.6)
Nkangala–Middelburg District	16 758	1 226 500 (1 308 130)	47.6 (54.6)
Part of Gert Sibande–Ermelo District	14 530	589 305 (584 924)	53.2 (60.7)
Bojanala Platinum–Rustenburg District	18 333	1 268 618 (1 507 506)	49.5 (55.7)
Part of Ngaka Modiri Molema–Mafikeng District	17 356	619 674 (611 143)	62.1 (67)
Ekurhleni–Germiston	1 975	2 724 229 (3 178 471)	38.2 (46)
Part of Sedibeng–Lesedi District	1 484	66 507 (99 520)	44.7 (51.6)
Part of West Rand & Metsweding District	4 087	692 576 (820 994)	36.6 (44.2)
Total/Average	**216 246**	**13 026 158 (14 209 186)**	**51.8 (56.1)**

Notes: Source: (Stats–SA, 2006, 2008). Source of population and district area (Source: IFAD, 2010). Portions of Gauteng, Mpumalanga and North West that are within the basin, contribute population of over 5.4 million. The difference in population figures over the years is due to population dynamics.

### 4.3.1 Efforts to reduce poverty and food insecurity in South Africa

South Africa's development policies, post 1994, have focused on the eradication of poverty, meeting basic food and non-food needs, and building the economy through rural development programs (RDP) – (LBFP, 2010). However, by 1997, the 'Growth, Employment and Redistribution' (GEAR) macroeconomic strategy was established resulting in the adoption of a pro-market policy (LBFP, 2010; PROVIDE, 2005). It is reported that pensions and grants (old age and child grants) are the main sources of income for rural households in the basin (LBFP, 2010). While availability of water and sanitation were afforded high priority in the strategy, the government made good progress in providing free basic water.

Growing concerns about climate change, sustainability and the on-going global financial crisis within the geopolitical landscape have brought more challenges to the efforts made to eradicate or minimize poverty (DBSA, 2011). The nature and form of economic growth and job creation have not been sufficient to address high levels of poverty and inequality (DBSA, 2011), and the rural areas are the most affected. A more recent strategy adopted by the South African Government is the 'Medium-Term Strategic Framework' that identified a number of priorities for the period 2009–2014, including the improvement of the quality of basic education, quality of life and health, promotion of rural development with a focus on former homeland areas, improvement of the quality of household life and protection of environmental assets and natural resources, among others. According to Motala (2010), social grant incomes and food garden initiatives help households to afford a basic and stable level of nutrition, and protect them against food insecurity. Furthermore, the Department of Agriculture developed an Integrated Food Security Strategy, which identified five priority areas of intervention that included increasing household food production, food trade and distribution, increasing income opportunities, improving nutritional status, and enhancing institutional support networks (DBSA, 2011). Furthermore, the strategies to eradicate hunger, malnutrition and food security by 2015 include increasing household food production and trading under smallholder farming systems, income generation and job creation opportunities, nutrition and food safety, safety nets and food emergencies management systems, stakeholder dialogue and improving information management systems (Stats-SA, 2012). Altman et al. (2009) argue that although social grants have contributed the most to reducing poverty and food insecurity among poor households, their current high levels are arguably not sustainable. Improved small-scale agricultural production (rain-fed and irrigation; crop and livestock), supported by input and output markets, improved access to land, technology, credit and training, enhancing the ownership and exchange entitlements of the poor in the trade of agriculture are proposed as potentially sustainable contributors to food security (Altman et al., 2009).

Figure 6: South Africa rural poverty maps at district level in 2003 (a), 2007 (b) and 2010 (c)
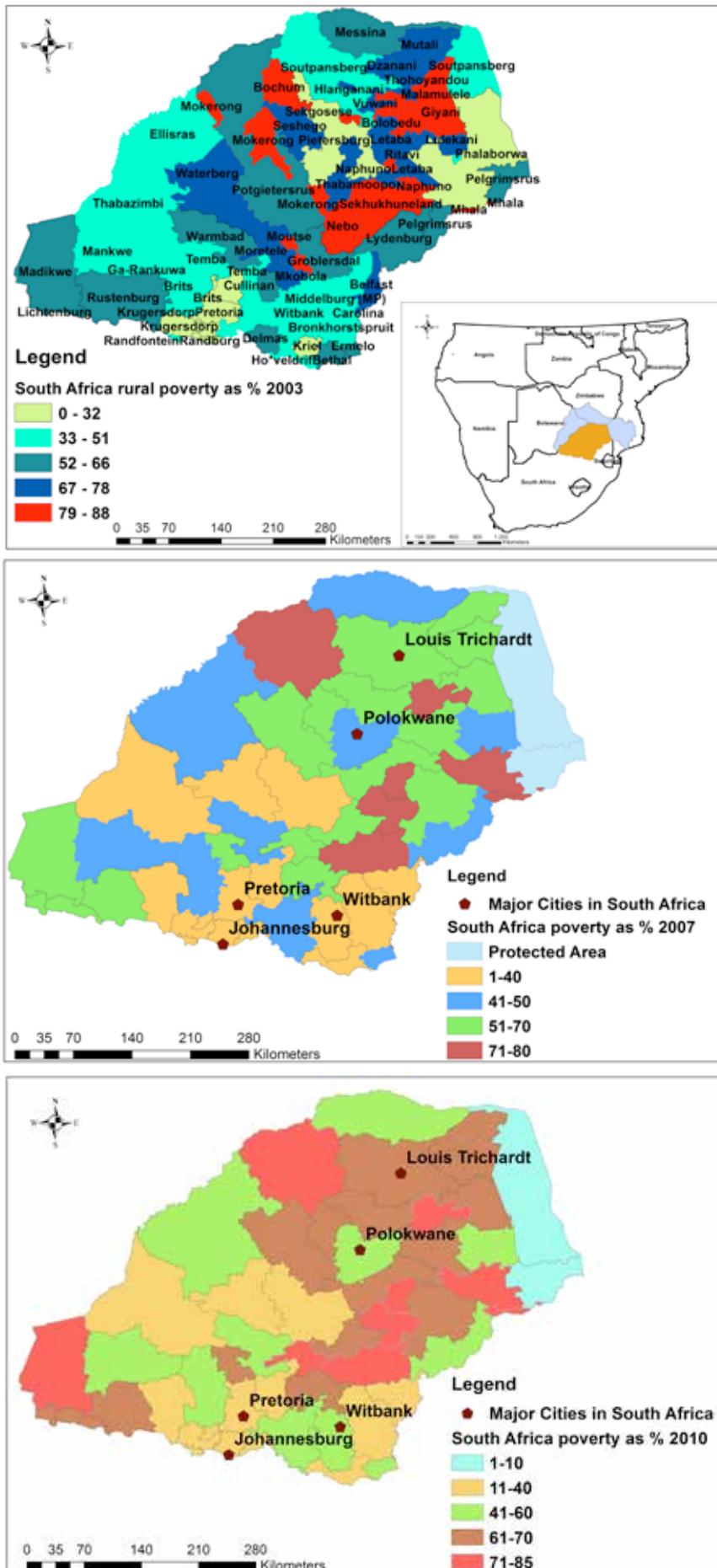
Figure 7: South Africa rural food insecurity maps at district level in 2003 (a), 2007 (b) and 2010 (c)
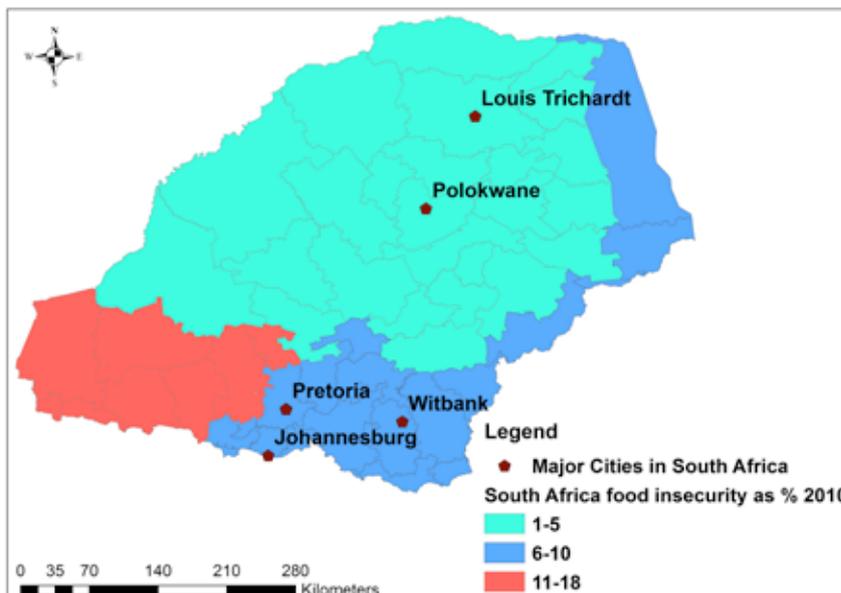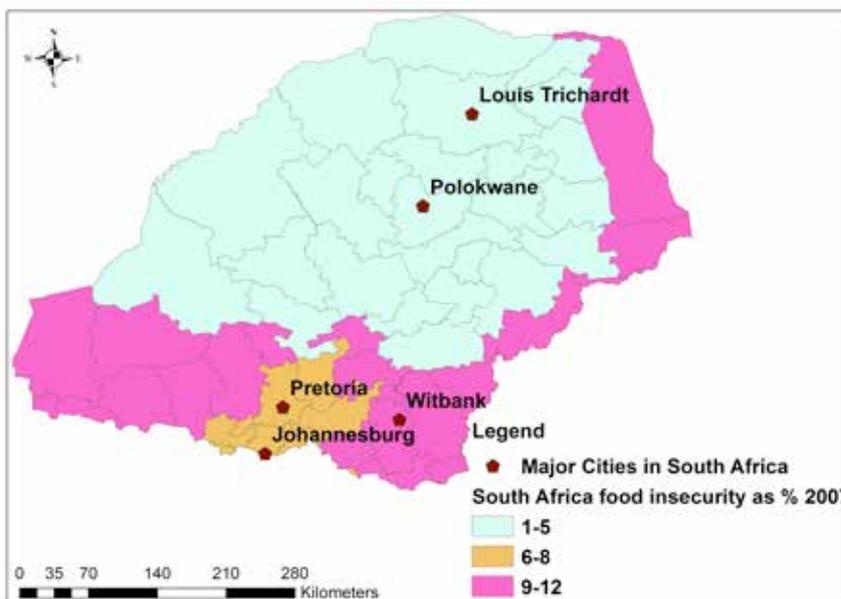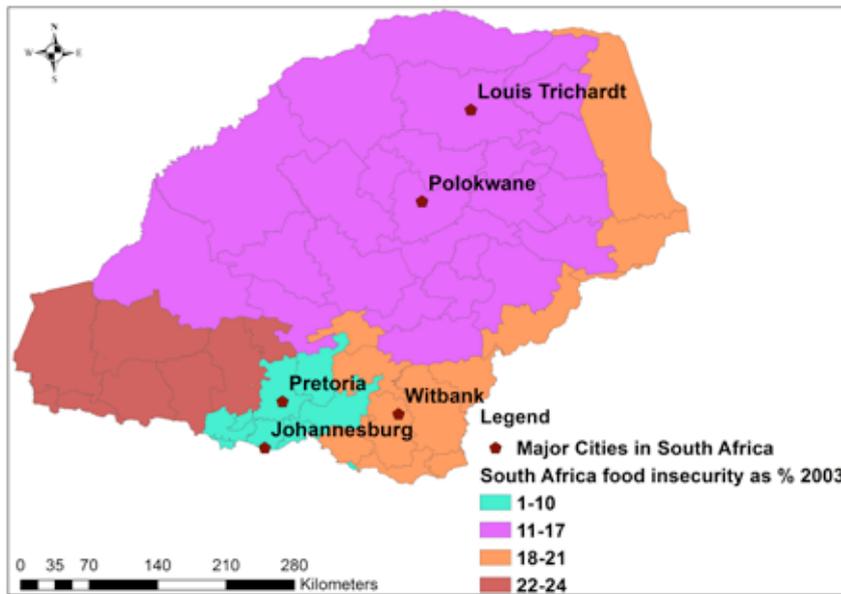
4.4   Zimbabwe rural poverty and food insecurity mapping

The district poverty levels for 2003 and 2011 are presented in Figures 8a and 8b, respectively, and Table 6, while food insecurity distributions for 2003 and 2011 are presented in Figures 9a and 9b, respectively, in the part of the Limpopo Basin that is in Zimbabwe. From a total population of 1.32 million people, an average of 74.9% were classified as poor in 2003, while approximately 0.97 million people, or 68.7%, were classified as poor in 2011 (Table 6). The proportion of households below the Food Poverty Line (very poor) increased from 20% in 1995 to 48% in 2003, while the proportion of households below the Total Consumption Poverty Line (TCPL) (poor) increased from 42% in 1995 to 63% in 2003 (LBFP, 2010). This poverty increase was due to a political and economic crisis, characterized by hyperinflation, negative gross domestic product (GDP) growth and loss of formal jobs (Dekker, 2009). The poverty statistics have now (2011) changed due to stabilization of the economy. Based on the 2003 statistics, among the districts in the Limpopo River Basin (Figure 8a), Mzingwane had the highest proportion of the population (84%) that was below the poverty line, followed by Bulilima-Mangwe with 74%. Matabeleland North, the driest and least productive areas in the country had 70% of its inhabitants classified as poor, confirming the obvious correlation between poverty and water availability. In 2011, Umguza had the highest (89%) poverty levels. Female-headed households had a higher poverty incidence (68% below the Total Consumption Poverty Line (TCPL) than male-headed households (60% below the TCPL) – (MPSLS, 2003)). With the rise in unemployment and consequent male migration away from rural areas to urban areas, female-headed households are becoming increasingly common and, as usual, the most disadvantaged (LBFP, 2010; MPSLS, 2003). Other vulnerable groups in rural areas are families with small plots of land, or those without irrigation in dry areas, or without access to draft animals. These households rely increasingly on remittances and emergency aid (http://www.ruralpovertyportal.org/web/guest/country/home/tags/zimbabwe). According to FAO (IFAD, 2010), the rural population in the Limpopo Basin portion of Zimbabwe was estimated at 0.9 million people in 2001.

Table 6: Population, area and percentage of poor by district in the Limpopo River Basin, Zimbabwe

District	Area of district (km²)	District population 2003 (2012)	Poverty level (%) in district 2003 (2011)
Umguza District	6 523	73 314 (87 518)	96 (88.8)
Bubi District	6 071	47 712 (62 188)	75 (88.8)
Beitbridge District	13 795	104 212 (80 335)	45 (61.5)
Matobo District	7 605	998 36 (93 991)	68 (61.5)
Insiza District	8 746	86 307 (99 793)	64 (61.5)
Gwanda District	11 396	130 021 (136 777)	74 (61.5)
Umzingwane District	2 896	58 569 (62 510)	91 (67.4)
Mberengwa District	5 350	183 712 (186 164)	74 (70.9)
Mwenezi District	14 346	125 711(166 263)	81 (70.9)
Chiredzi District	18 776	232 616 (276 842)	75 (61.5
Bulilima–Mangwe District	13 083	172 788 (157 762)	81 (61.5)
Total/Average	**108 587**	**1 314 798 (1 410 143)**	**74.9 (68.7)**

Source: (Zimbabwe National Statistics Agency, 2012; MPSLS, 2003; WRI, 1996)
Note: Using the figures in Table 6, the population density in 2012 in the basin ranges from 6 persons/km² in Beitbridge District to 35 persons/km² in Mberengwa. rural district.

Above: Access to unprotected water sources by some rural communities still pose a health hazard in the Limpopo Basin
Below: Improved rural water access through community borehole in the basin
Photos: WaterNet

4.4.1 *Efforts to reduce poverty and food insecurity in Zimbabwe*

In Zimbabwe, the 'Poverty Alleviation Action Program' (PAAP) policy framework guides strategies aimed at alleviating poverty and food insecurity, especially in rural areas, through improved livelihoods, access to resources, infrastructure and services and increased knowledge (LBFP, 2010). In addition, the 'National Policy on Drought Management' (NPDM) highlights the need for intensive research on improving the tolerance of staple food crops to drought and disease, and technologies that promote more efficient use of water and mitigate food security risks (Szonyi et al., 2010). These strategies are in line with the LBDC research on AWM interventions (http://sites.google.com/site/cpwfbdceoi).

Figure 8: Zimbabwe rural poverty maps at district level in 2003 (a) and 2011 (b)
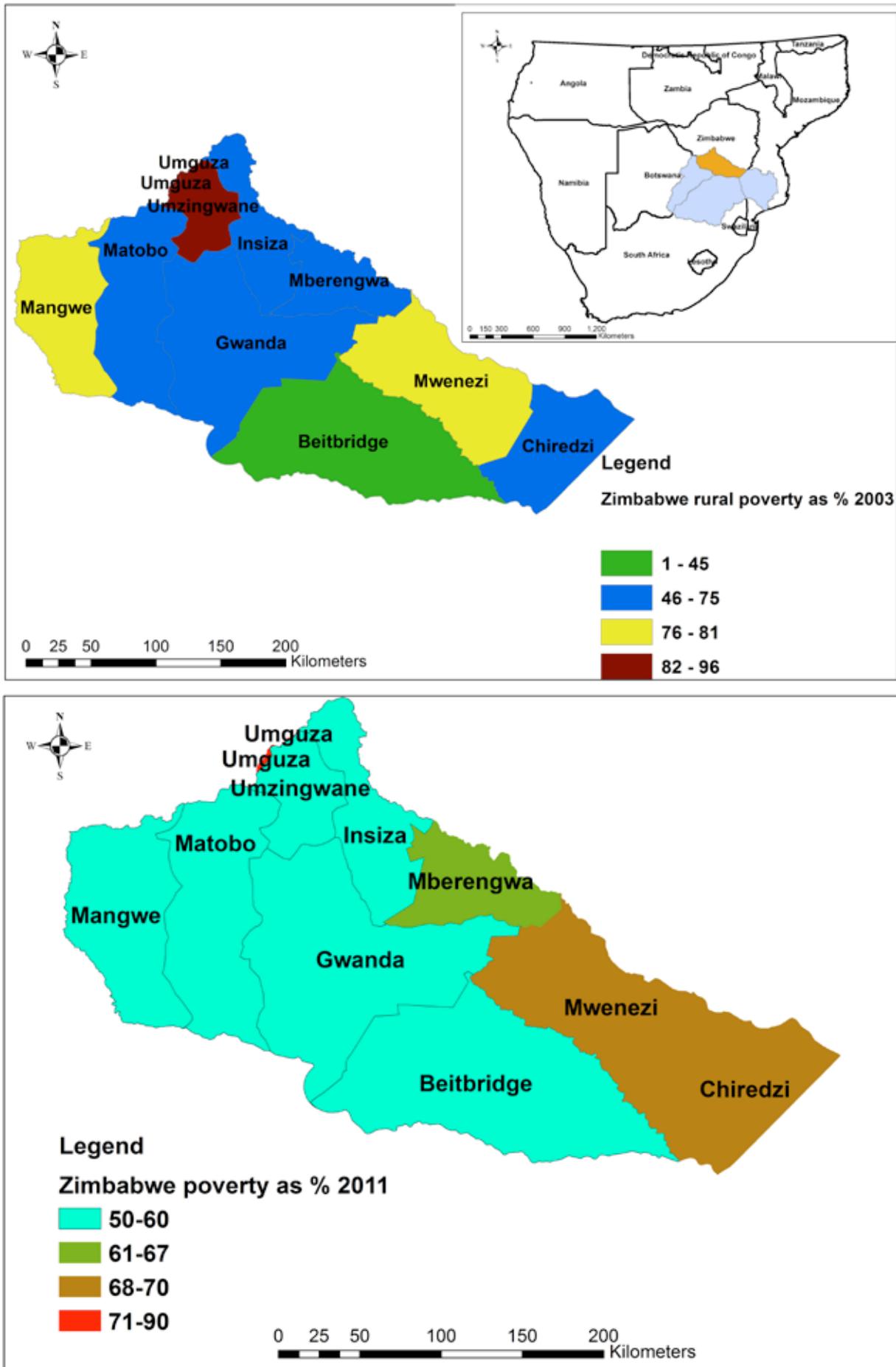
Figure 9: Zimbabwe rural food insecurity maps at district level in 2003 (a) and 2011(b)
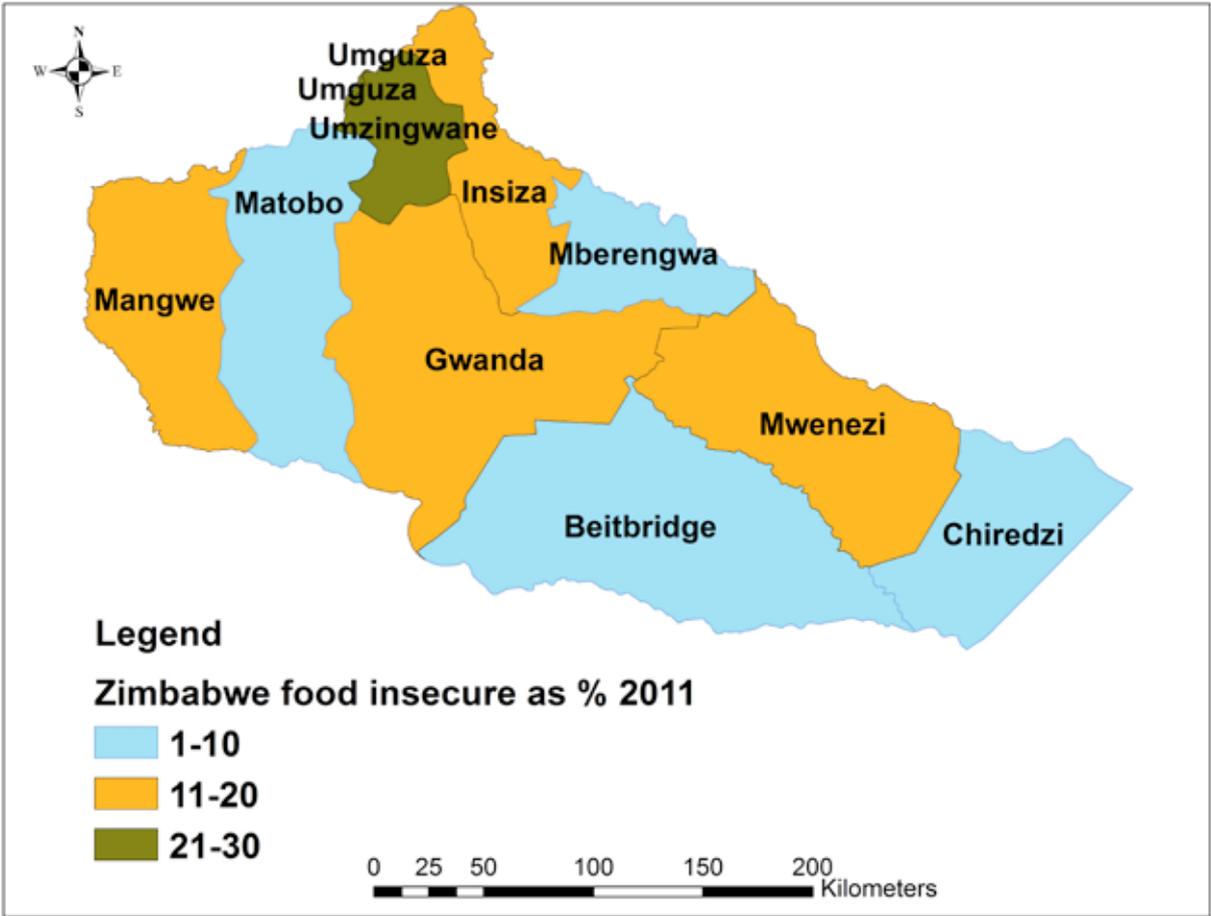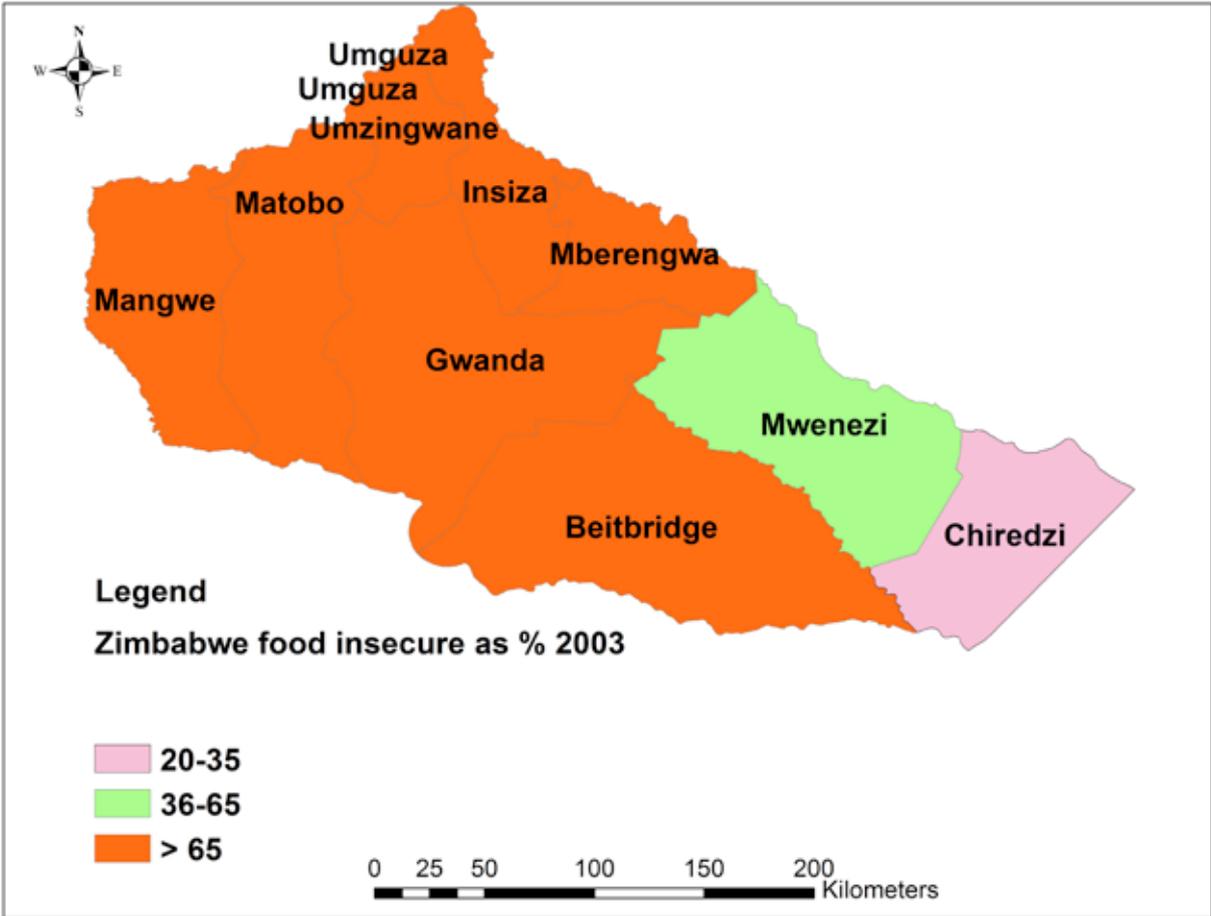
4.5   Poverty and population changes

The population data in the basin indicates a significant increase from 9.2 % to 20.1% in part of the basin within the countries (Figure 10) compared to less than 5% at country levels (http://data.worldbank.org/country/). There was a significant decline in the proportion of persons living below US$1.25/day per person between 2002/2003 and 2009/2010 in Botswana, Mozambique and Zimbabwe, while South Africa showed a slight increase (less than 5%) from 2007–2010. The rate of poverty more or less remained unchanged in the basin. Though there is a slight decrease in poverty incidence, the absolute numbers of the poor population have increased due to the population increase.

Figure 10: Poverty changes in the Limpopo Basin

(a) Botswana (2003–2009/2010)
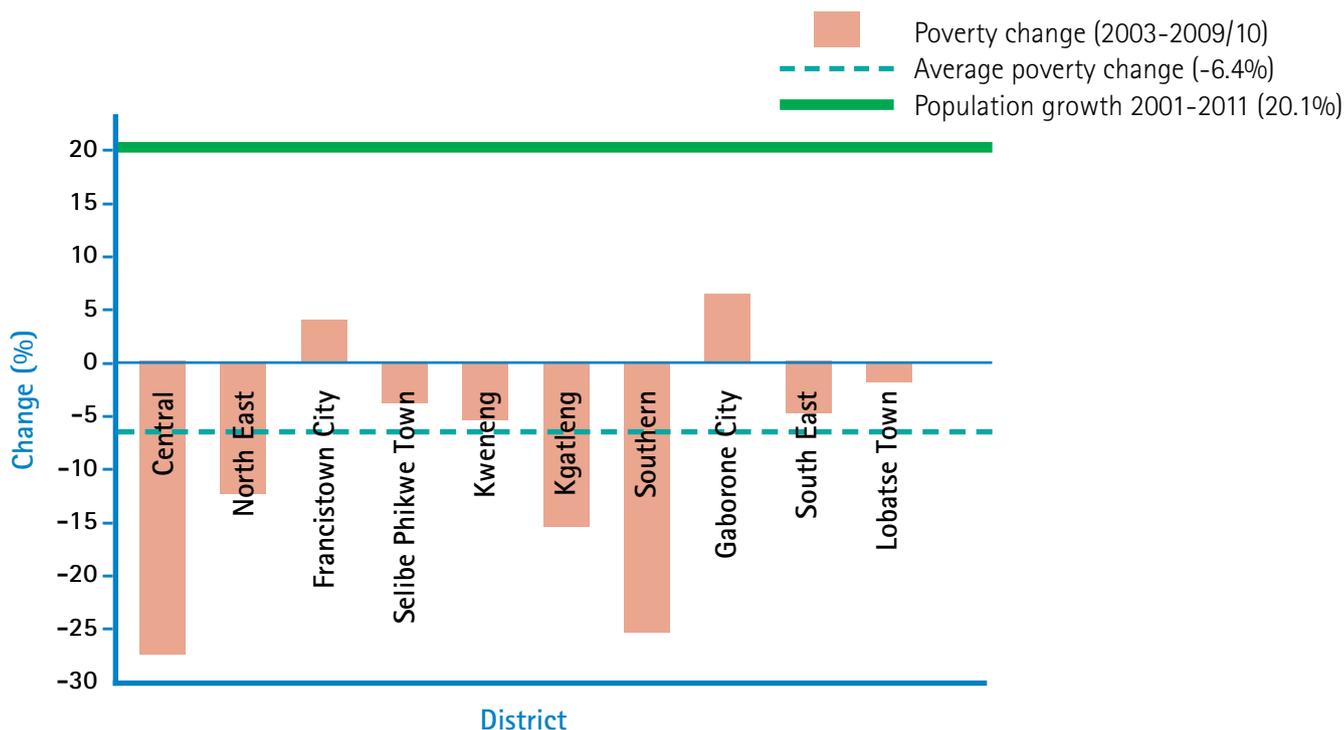
(b) Zimbabwe (2003–2011)

(c) South Africa (2007–2010)

Legend:
- Poverty change (2007-2010)
- Average poverty change (4.3%)
- Population growth 2007-2011 (11%)

Y-axis: Change (%)

Districts: Sekhukhune, Mopani, Vembe, Capricon, Waterberg, Part of Ehlanzeni–Nelspruit, Nkangala–Middelburg, Part of Gert Sibande–Ermelo, Bojanala Platinum–Rustenburg, Part of Ngaka Modiri Molema–Mafikeng, Ekurhleni–Germiston, Part of Sedibeng–Lesedi, Part of West Rand & Metsweding

X-axis: District

(d) Mozambique (2003–2008/2009)

Legend:
- Poverty change (2003-2008/9)
- Average poverty change (-6.4%)
- Population growth 2007-2012 (11%)

Y-axis: Change (%)

Districts: Chibuto, Chicualacuala, Chigubo, Chokwe, Funhalouro, Guija, Mabalane, Mabote, Manjacaze, Massangena, Massinga, Massingir, Panda, Xai-xai (town)

X-axis: District
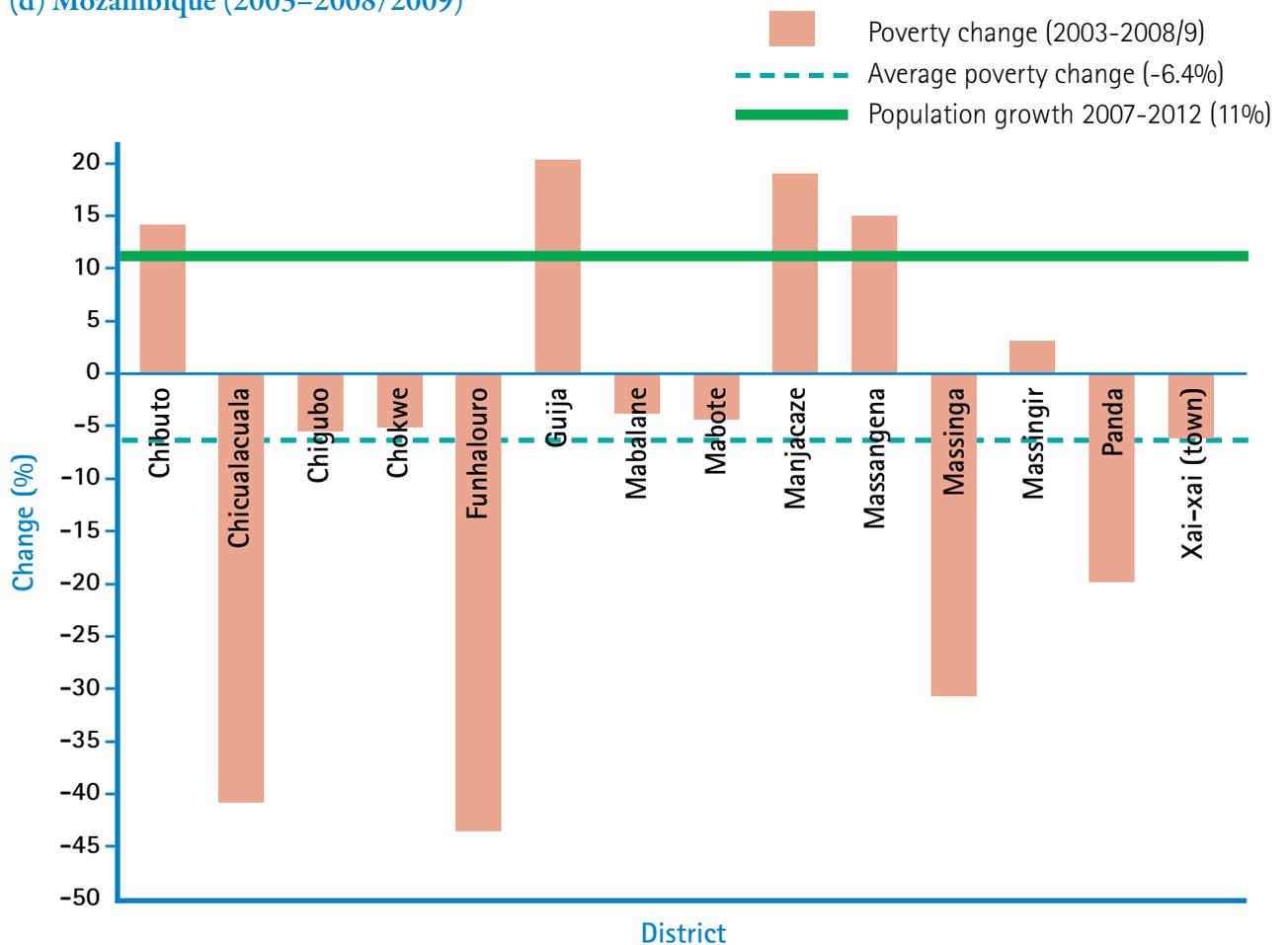
4.6   Livelihood zones in the LBDC study sites

Livelihood zones and annual rainfall and runoff in the LBDC study sites are presented in Table 7.

Table 7: Livelihood zones and mean annual rainfall and runoff in the LBDC study sites

Site	Annual rainfall (mm)	Annual runoff (mm)	Livelihood zone	Livelihood Description
a. Mabalane (Gaza)	550-600	5-10	Interior Zone (Gaza)	The area is semi-arid and drought prone; remote and sparsely populated; livestock is important; hunting/gathering an option. The interior zones are rain-fed uplands with limited production potential and very poor market access (market is slightly better in Inhambane than in Gaza) (Lawrence et al., 2006; FEWS NET, 2011).
b.Chicualacuala/ Mabalane	500	5-10	Upper Limpopo Riverine -MZ36	Rainfall is sufficient to allow maize-based subsistence agriculture and small watered vegetable gardens. The main wealth of the area is in livestock, with more cattle than goats. Constraints to livestock ownership are lack of cash to buy animals, and the pressure to sell animals to buy food (creating a vicious cycle). Cultivation is by hand-hoe and ox-plough. Main food crops are maize, cowpeas, groundnuts, sweet potatoes and bambara nuts. Crop sales, included vegetables (tomatoes and cabbages). People buy treated seeds but almost no chemical fertilizers (FEWSNET, 2011).
c. Lotsane and Notwane	350 – 550	0-10	Central-Southern open access livestock and upland crops	The zone receives fairly good rainfall (favorable agro-climatic) and communities practice livestock (cattle and small livestock) and crop mixed farming. The vegetation is mainly savannah and grass species. High concentration of industries and commercial centers, rich agricultural potential and presence of mineral resources such as gold in Francistown, all contribute to this being the most attractive area for settlement (Rethman and Muhangi, 2009).
d. Lotsane and Palapye	350-400	0-5	Central-Southern livestock, upland crops and non-farm income	Zone is highly populated mainly due to better rains received, coupled with the economic opportunities due to several urban areas, good road network and abundance of industries. Improved road infrastructure to the various urban areas enhances market access. Households typically engage in crop and livestock production and engage in various off-farm income generating activities of craft making and petty trade. Main sources of food are own crop and livestock products, and purchase (Rethman and Muhangi, 2009).
e.Vhembe	450-500	5-10	Crop and livestock	Rain-fed mixed crop/livestock systems, arid to semi-arid. There is irrigation in some areas (Thornton et al., 2006). Irrigation is present where there are streams, boreholes and small reservoirs, with poor market access but good transport network.
f. Lambani and Nebo Plateau	450-650	15-20	Crop and livestock	Livestock only and rain-fed mixed crop/livestock systems in arid to semi-arid areas (Thornton et al., 2006). Vegetable market gardening. Irrigation is present where there are streams, boreholes and small reservoirs, with poor market access but good transport network.

Site	Annual rainfall (mm)	Annual runoff (mm)	Livelihood zone	Livelihood description
g. Gwanda	500-550 650-800 in northeast; < 450 mm in south and central areas	10-15	Beitbridge South Western Lowveld Communal; Cattle and cereal farming; Matebeleland Middleveld Communal	Middleveld: This zone covers communal lands in Natural Region IV. Livelihoods are characterized by rain-fed maize and other small grains. Cropping is supplemented by animal husbandry and various income generating activities including small-scale gold panning in the rivers (Tuli, Runde, Ngezi, Mundi, Umzingwane and Mwenezi), beer brewing and employment locally and in South Africa and Botswana. Cash cropping is carried out on a limited scale. Wildlife often destroys crops, despite being source of food. Livestock herds are large reflecting the availability of grazing land (FEWSNET, 2011; Southern Africa Livelihood Zones Database, 2013).
h. Insiza	500-550	10-15	Cattle and cereal farming	Zone covers vast areas in Natural Region IV and V across southern and central Zimbabwe and was affected by the Fast Track Land Reform Program that began in July 2000, with ranches sub-divided into either A1 or A2 farms. Soils are more suitable for cattle and game than for agriculture; hence crop productivity is relatively low. Newer farmers have introduced more cereal production on land previously reserved for game and cattle ranching. Maize, sugar beans, sorghum and millet are grown with some wheat produced in irrigation schemes. Game ranching is being replaced by cotton production (FEWSNET, 2011).
i. Matobo	Normally < 475 mm	10-15	Beitbridge South Western Lowveld Communal; Cattle and cereal farming	Zone covers areas in Natural Region V. the Limpopo, Tuli, Umzingwane and Shashi pass through this zone, along with disused mines, provide opportunities for gold panning. Livelihoods are primarily agro-pastoral. Crops grown are small grains and cotton due to the drier weather pattern. Food and cash income from animal husbandry is augmented by seasonal work income from A2 and large-scale commercial farms or by migratory work in South Africa and Botswana. Animal holdings are large, especially around Beitbridge, as the land is more suited to grazing. Arable land for crop cultivation is generally small (FEWSNET, 2011).

Source for rainfall and runoff data (LBFP, 2010, LBPTC, 2010).
Notes: c: similar areas are Eastern Botswana, Southern, Kweneng and Central Districts, Southern District and parts of North East District; d: similar areas are towns and cities in the Southern, Kweneng, South East, Kgatleng, Central and North East Districts; g: similar areas are northern Matobo, northern Gwanda, Umguza, Bubi, Umzingwane, southern Insiza and western Mberengwa; i: Similar areas are Beitbridge, Chiredzi, southern and central Gwanda, southern Matobo, and north-western and southern Mangwe

4.7   Discussion of alleviation efforts by basin countries

Overall, poverty and food insecurity in the Limpopo Basin are related to climate/environment, geographical location (rural areas), natural resource base for livelihoods, low smallholder farmer productivity, vulnerability to disease, poor access to credit facilities (Sullivan and Sibanda, 2010), unemployment, limited access to water (Mulligan et al., 2011), low education levels (human capital) and poor infrastructure such as roads, clinics, markets and so forth. Certainly, given the poverty profile that is typical of the basin, improved agricultural productivity contributes to a reduction in poverty and food insecurity in the basin (LBFP, 2010). Using the 2003 poverty line of US$1/day per person as a basis for poverty ranking, Mozambique has the highest rural population (37.9%) below the poverty line among the four countries that the basin extends across (Sullivan and Sibanda, 2010), and is followed by Zimbabwe and Botswana which recorded 36% and 33.3%, respectively (LBFP, 2010; Sullivan and Sibanda, 2010). For the poverty lines of US$1.25/day per person (2007–2011), Zimbabwe (68.7%) has the highest population below the poverty line among the four countries, followed by Mozambique (68.2%), South Africa (56.1%) and Botswana (20%).

A gender dimension of the poverty and food insecurity analyses for the different years in the four countries consistently showed that the female-headed households had higher poverty and food insecurity incidences than the male-headed households. This reflects the general gender disparity in access to productive resources that include land and water (LBFP, 2010). Female-headed households are susceptible to high poverty and food insecurity as they are characterized by high dependency rates, with fewer adults of working age, and significant rates of unemployment (female unemployment rates and wage gap in earnings are higher in comparison to those of males) – (Lahiff, 2007). Hence, they are increasingly taking subsistence farming as an additional livelihood strategy (Stats-SA, 2012).

In response to the extent of poverty and food insecurity in the basin, national policies in the four countries have focused on poverty reduction using various strategies, for example: public sector reforms; environmental protection; integrated rural development; human resource development; disaster management; land and natural resources development, including water resources; small-scale rain-fed and irrigation agriculture, HIV and AIDS treatment or preventive strategies and women's empowerment (LBFP, 2010; Siphambe, 2003; Bolnick, 2000). Changing the basin's poverty profile will require an understanding of the drivers of poverty in order to identify the right levers required to bring about the desired changes (DBSA, 2011), especially under on-going economic, political and climatic changes that project a decrease in precipitation in the Limpopo River Basin (Mulligan et al., 2011; IPPC, 2007). Sullivan and Sibanda (2010) proposed a number of strategies that include on-farm interventions, such as rainwater harvesting and conservation agriculture, enabling policies, infrastructure investment, markets and strengthened institutions that work closely with the rural poor to achieve poverty reduction and improve livelihoods.

According to ZimVac (2006), the food insecure households in the basin are more likely to be: large households with orphans; those headed by people with low educational levels; those without well-resourced relatives; those with a mentally or physically challenged household member; those headed by the elderly or a child; and those with a household head or member who is chronically ill. As households face a diverse set of challenges, a variety of solutions are required to help these households. In general, the identified food shortage coping strategies that households had adopted included: skipping meals; reducing portion sizes; borrowing food; eating less preferred foods; eating wild fruits; eating immature crops; begging; and engaging in casual labor (mainly for construction and short-term labor migration to cities); reduced expenditure on non-essential items such as clothing, alcoholic drinks, cigarettes and phone airtime; increased sale/slaughter of livestock; intensification of self-employment activities, (i.e., marketing of reeds, grass, crafts, firewood, local alcoholic drinks, charcoal and building poles); growing

Maize inter-cropped with beans under drip irrigation to improve food security in the water scarcity Limpopo Basin
Photo: M. Magombeyi

drought-resistant and short-season crop varieties such as sweet potatoes and beans; use of reserved grain stock by middle and better-off wealth groups; increased cash remittances; and social support/gifts (FEWSNET, 2012; Stats-SA, 2012; SADC, 2010; ZimVac, 2006).

A comparison of poverty and food insecure people (Figures 2–9) for all the districts shows a lower proportion of food insecure (0–40%) than poverty stricken people (0–95%). This could be due to enhanced government and nongovernment food social safety networks in the four countries over which the basin extends. Food insecurity, derived from mostly a 30-day recall on the frequency of food shortage in the rural household, is one facet of poverty that is more dynamic over a short period (months) than that derived from a comprehensive assessment of incomes and expenditures, including the asset-base of the rural households. For example, Zimbabwe and Mozambique carried vulnerability assessments in March and October of the same year, and there were noticeable food insecurity changes between the two periods. Proximity to harvest time in March reduces the food insecurity, while markets play an important role in improving food access in the December to February period when food prices are at their peak as food reserves are low and most households turn to markets to source for food. Therefore, food insecurity maps tend to show more short-term conditions and reflect changes in food availability and prices in local markets, while poverty maps seem to reflect more structural aspects of livelihood asset deprivation. Therefore, if the overall aim of the policy is short- to medium-term relief efforts, food insecure maps are more appropriate, whereas long-term development plans and investments require the use of poverty maps.

Poverty stricken households lack money or the means to earn an income sufficient to buy food. Hence, food security has to be addressed within the context of other developmental issues such as poverty, increasing prices of commodities, agricultural inputs and energy (e.g., electricity), poor market infrastructure, diversifying sources of income, social protection, social safety nets, rural and urban development, changing household structures, access to health, education, land, water and sanitation, and other shocks such as civil unrest, outbreak of livestock and crop diseases and pests, and HIV and AIDS prevalence (SADC, 2010).

5: Mapping CPWF-LBDC sites on smallholder farms and landuse

The identified LBDC study sites, PGIS workshop sites and smallholder subsistence farming locations in the South African portion (Andersson et al., 2013) of the Limpopo River Basin are shown in Figure 11. Lack of similar data on subsistence farming from the other three basin countries (Botswana, Mozambique and Zimbabwe) precluded their subsistence farming locations from being presented in Figure 11. The crop areas on both commercial and subsistence agriculture are shown in the Limpopo Basin's land use in Figure 12. Rain-fed agriculture covers 40% of the land in the basin and uses 40% of the water in it (Sullivan and Sibanda, 2010; Hanjra et al., 2009). On the South African portion of the basin, the districts with the highest poverty incidences coincide with those of subsistence farming areas.

Figure 11: Smallholder farm locations (Andersson et al., 2013), AWM cases from consultations, PGIS and LBDC study sites
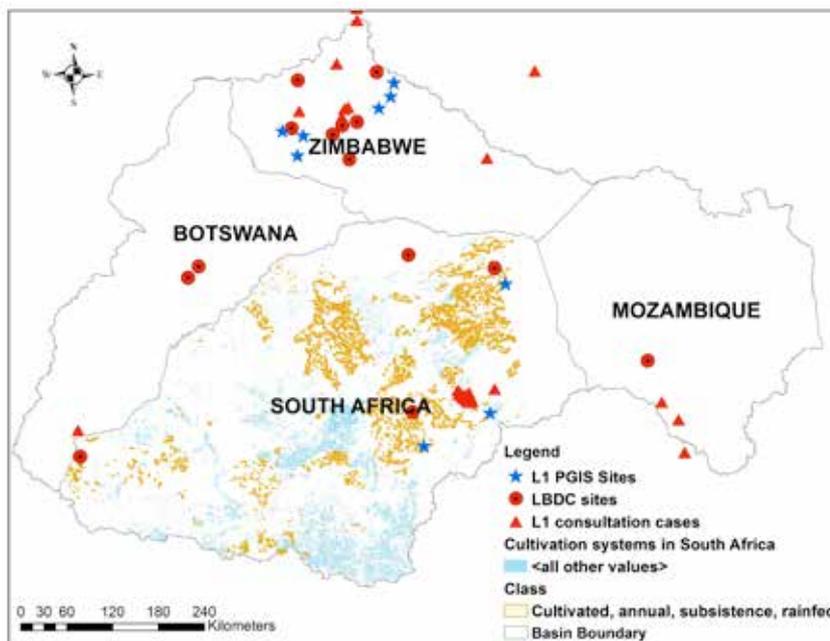

Figure 12: Limpopo Basin landuse (LBFP, 2010), AWM cases from L1 consultations and LBDC study sites
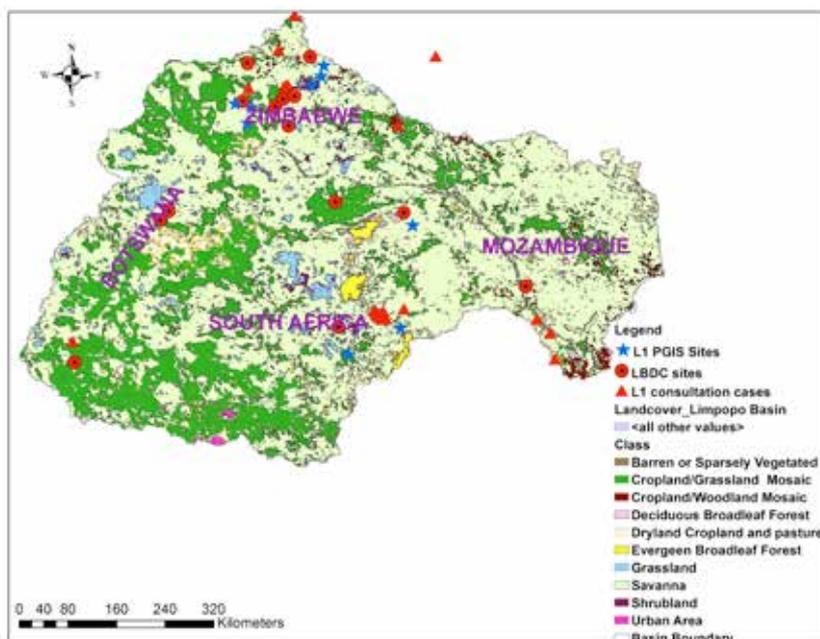
6. Overlap of poverty incidence, L1 consultation cases, smallholder farming areas and LBDC study sites

The overlap of LBDC study sites, AWM cases from L1 consultations and Limpopo basin-wide district poverty levels, which were derived by harmonizing poverty data classes from each basin country are shown in Figure 13a for 2003 poverty data and Figure 13b for most recent available country poverty data. At the district level, less than 50% of the population in Botswana is affected by poverty, while in the other three basin countries, most of the districts have poverty incidences ranging from 50% to 85% (Figure 13b). The AWM intervention cases from the L1 consultations are not widely distributed in the basin, though certain cases have occurred in areas of high poverty incidence (Figures 13a and 13b). The LBDC study sites include the Notwane Catchment in Botswana, which falls within a peri-urban area of Gaborone (Figure 13a and 13b), while Nebo Plateau area in the Sekhukhune District and Lambane area in Tulamela Local Municipality in South Africa are located within areas of the highest poverty incidence (Figure 13b). The Mabalane Site with 72% (2003) and 70% (2008/2009) poverty levels, is also a high poverty area, though not the poorest in the Mozambique portion of the Limpopo Basin (Figure 13b). The Chigubo District in Mozambique had a poverty level of 95% (2003) and greater than 80% (2008/2009), which is the highest in the country from both 2003 and 2008/2009 poverty data. In Zimbabwe, Uzingwane/Mzingwane and Umguza had the highest poverty levels, while Mwenezi had the second highest poverty level in 2003 (Figure 13a). However, Umguza, Bubi, Mberengwa and Mwenezi districts had the highest poverty levels, with a range of 71–89% in 2011 (Figure 13b). These districts can be explored for possible future PGIS workshop and research sites to understand the contextual complexity of how improved AWM interventions contribute to improved food production and livelihoods. In Mozambique, the following districts can be explored as well: Chigubo, Mabote, Massangena and Massingir, which had a greater than 80% poverty incidence in 2008/2009 (Figure 13b), while in South Africa, Blouberg, Greater Letaba, Elias Motsoaledi and Ramotshere Moiloa Local District Municipalities can be explored (Figure 13b). It should be noted that some of the 2010 district names shown in Figure 13b in South Africa have changed from those of 2003 (Figure 13a) as some of the district boundaries were re-demarcated after 2003, resulting either in merger of districts or creation of new districts.

In general, LBDC research sites are located in target (poor) areas in the four countries, but are not necessarily those with the highest poverty levels (Figures 13a and 13b). Although poverty rankings at the district level do not generally reflect income levels at individual household levels, the former still play an important role of providing a rational basis for targeted development interventions. Hence, they should be considered part of the suite of significant factors that facilitate the CPWF-LBDC site selection process.

Figure 13a: Overlap of LBDC study sites, PGIS sites, AWM cases from L1 consultations and poverty levels of 2003 in the Limpopo Basin
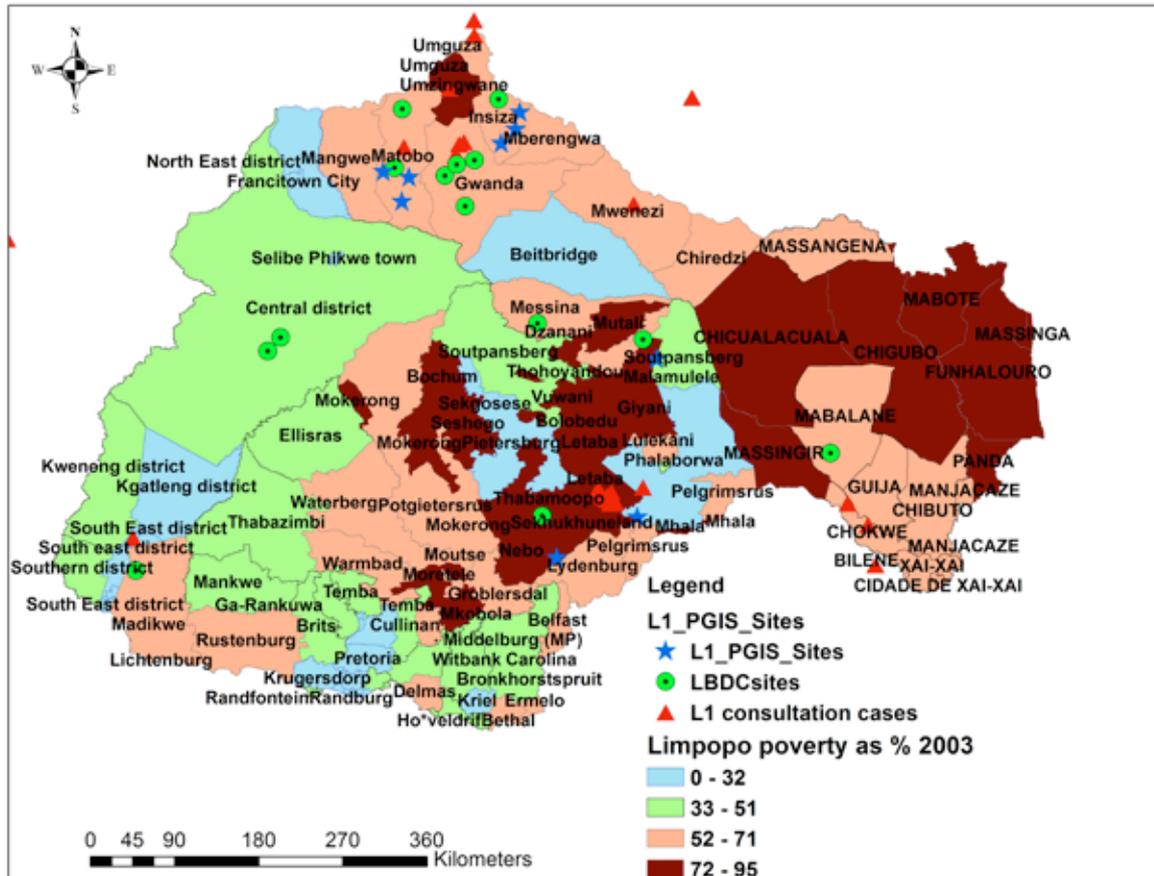

Figure 13b: Overlap of LBDC study sites, PGIS sites, AWM cases from L1 consultations, mean annual rainfall and most recent poverty levels in the Limpopo Basin. Data sources for poverty, Botswana (2009/2010), Mozambique (2008/2009), South Africa (2010) and Zimbabwe (2011)
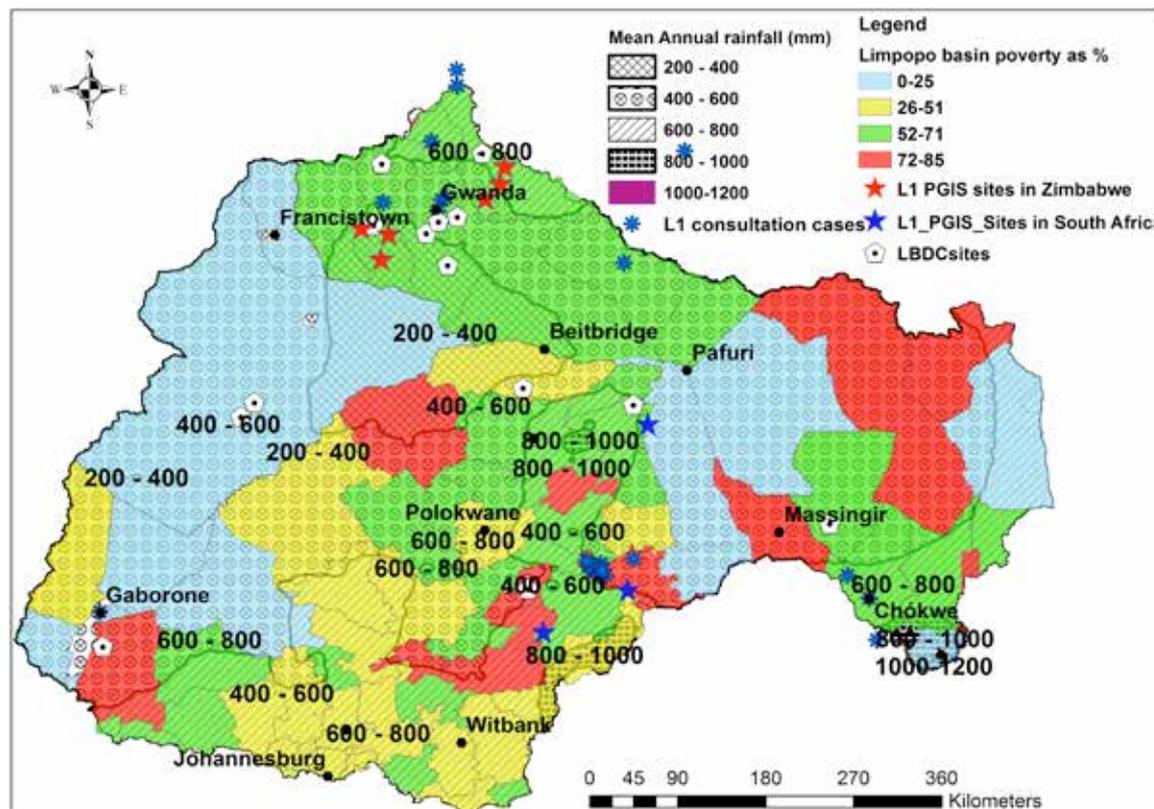
Establishing uniformity in district poverty comparisons of countries across the Limpopo Basin was not possible as the four countries used different definitions of poverty, collected poverty data at different times, and used different survey designs and design methods for census and household surveys. The development of a common poverty line applicable to the four countries having the same time frame is the means with which a comparative analysis of poverty can be made. The poverty rates are influenced by the choice of poverty line, while food insecurity levels are influenced by the respondents' ability to recall frequency of food shortages. Using district-level information can conceal the existence of poverty pockets within otherwise relatively well-off districts, which would lead to poorly targeted schemes being implemented to mitigate the incidence of poverty and food insecurity. In addition, the poverty index too has its limitations, in that, it is strongly influenced by community and household-level factors that are generally subjective and reflected in the responses of the research participants (Booysen et al., 2005). Another limitation of aggregated indicators such as 'wealth and poverty' is the inability to differentiate the causes from the consequences of a given situation. For instance, are families poor because they practice rain-fed agriculture or do they mostly practice rain-fed agriculture because they are poor? The strengths and limitations of any poverty measure depend on the context and purpose for which it is used. Local level information on poverty and food insecurity helps in refining district level information, and in streamlining intervention strategies that are both cost-effective and efficient in alleviating poverty and food insecurity.

7: Conclusion

The dominant livelihood zones within the CPWF-LBDC Phase II research sites include livestock (cattle and small livestock) and crop mixed farming with different access levels to markets. Other income generating activities include small-scale gold panning, charcoal selling, crafts, beer brewing, and employment locally and in South Africa and Botswana.

Addressing both food insecurity and poverty is important for achieving rural development. Although food insecurity features in the poverty profiles in the basin, it is transitional in comparison to poverty profiles that are longer-term in nature, because they reflect asset accumulation. The food insecurity and poverty maps, therefore, convey both seasonal and longer-term conditions that should be addressed by appropriate intervention measures, including targeted policies and programs aimed at the reduction of food insecurity and poverty. The increasing dependence on the labor market by the food insecure population (von Braun, 1995), favors the creation of employment opportunities as one of the poverty-reduction strategies, coupled with addressing the challenges of producing, transporting, and marketing an adequate food supply for the growing populations. Targeted food aid under social safety nets and input and output subsidies programs for crop and livestock productions should continue throughout the basin for poor socioeconomic groups.

As signatories to the Millennium Development Goals, the four countries over which the basin extends have committed themselves to halving the proportion of people who suffer from hunger by 2015 (van den Boom, 2011). In order to monitor targeted and decentralized poverty reduction efforts by governments, private sector and donor community requires an in-depth analysis of poverty and food insecurity patterns as well as an understanding of the multi-dimensional complexity of poverty profiles, and the need to update poverty thresholds annually by using the Consumer Price Index (CPI) to allow for changes in relation to cost of living (inflation factor). The LBDC research sites and associated water management interventions are well targeted in Botswana, Mozambique, South Africa, and Zimbabwe, e.g., in places where poverty and food security are priority concerns, and natural resource constraints are limiting development efforts. By cross checking past and current CPWF Limpopo Basin efforts, it is clear that certain similarities can be drawn between the four countries:

1. Poverty incidence appears higher in drier areas of the basin.
2. Female and child-headed households are the most affected by poverty in the four countries, irrespective of differences in national censuses. Other vulnerable groups in rural areas are families with small plots of land, without irrigation in dry areas, or without access to draught power, the elderly, children, youth, disabled, and families living with AIDS. Hence, poverty reduction programs should target these vulnerable groups as a matter of priority.
3. Current LBDC sites are located in districts with high poverty incidences, but in certain countries these sites are not necessarily the poorest of the poor areas.
4. The LBDC sites in South Africa are located in the smallholder farming areas where the poorest communities are found.
5. The brief review on national poverty alleviation efforts, suggests that LBDC is well aligned to national initiatives.

The scope of this study is such that it was impossible to disaggregate poverty data to the individual or to the community level. People in different circumstances may have different levels of economic welfare at the same level of income (Ravallion and Lokshin, 2005). The poverty trends shown in the paper based on 2003 and 2007–2013 data are more important than the exact poverty values. Importantly, further efforts can be made to estimate wealth, (i.e., the inverse of poverty indices) at field sites and communities, so that the overall results can be related to targets of LBDC activities in alleviating poverty and food insecurity.

The work prepared in this paper was used in L1 project assessments as well as for background information for other LBDC projects.

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About CPWF

The CGIAR Challenge Program on Water and Food (CPWF) was launched in 2002. The CPWF aims to increase the resilience of social and ecological systems through better water management for food production (crops, fisheries and livestock). We do this through an innovative research and development approach that brings together a broad range of scientists, development specialists, policy makers and communities, in six river basins, to address the challenges of food security, poverty and water scarcity.

The CPWF is part of the CGIAR Research Program on Water, Land and Ecosystems (WLE). WLE combines the resources of 11 CGIAR centers and numerous international, regional and national partners to provide an integrated approach to natural resource management research. The program goal is to reduce poverty and improve food security through the development of agriculture within nature. This program is led by the International Water Management Institute (IWMI).

About this R4D Paper

The Challenge Program on Water and Food Phase II for the Limpopo Basin Development Challenge (LBDC) project aims to develop methods, processes, and technologies to help resource-constrained smallholder farmers mitigate poverty and food insecurity through improved agricultural water management (AWM) strategies. The purposes of this paper are to: 1) Identify areas in the Limpopo River Basin with high levels of rural poverty and food insecurity; 2) Identify areas where AWM interventions are taking place; and 3) Check whether current activities of the CPWF in the Limpopo Basin are located in areas of need as per poverty profiles and geographical location of smallholder farms. The generated poverty and food insecurity maps were based on food security surveys and estimates of consumption or income-based welfare outcomes at the district level from 2003–2013. Poverty maps that highlight areas marginalized by resource constraints help in setting priorities for developing technologies and in deploying resources where they are most needed and likely to alleviate poverty and food insecurity. This work provides background information on the Limpopo Basin.

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