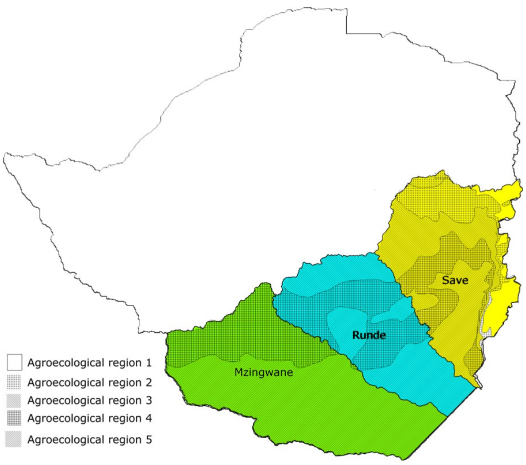
# Feasibility Study

# Building climate resilience of vulnerable agricultural livelihoods in Mzingwane, Runde and Save river basins in southern Zimbabwe




**Ministry of Lands, Agriculture, Water, Climate and Rural Resettlement**

**Republic of Zimbabwe**

**A study prepared by the Government of Zimbabwe with technical support from the United Nations Development Programme and the Climate Resilient Infrastructure Development Facility**

*Submitted, September 2017*

*Revised, November 2019*

## Foreword

Climate change presents one of the greatest threats to sustainable development in the Twenty-First Century. The impacts of climate change in Zimbabwe are experienced in the climate sensitive sectors of the economy such as agriculture, which is mostly rain-fed. Smallholder farmers, especially women, are highly vulnerable as increased climate variability and extreme events are threatening their food security, creating new dimensions of poverty and slowing socio-economic development.

In 2013, the Government of Zimbabwe launched a cluster based economic blueprint, the Zimbabwe Agenda for Sustainable Socio-Economic Transformation (ZimAsset). The blueprint provides a clear and coherent plan to achieve sustainable development and tackle climate change in its Food and Nutrition Security and Infrastructure and Utilities clusters. Furthermore, the Government developed the National Climate Change Response Strategy in 2014 and the Climate Policy in 2017 to drive the country towards climate resilience and a carbon neutral Zimbabwe. Recognising the increased vulnerability of a large part of the rural population and the potential of smallholder farmers to contribute to the agriculture sector and the wider economy, it is a priority of government to address smallholders' climate resilience, particularly those living in southern areas of the country that are heavily dependent on rainfall.

ZimAsset and the National Climate Change Response Strategy recognize that the enormous scale of the challenges presented by climate change requires the mobilization of both local and international climate finance. This Feasibility Study aims to inform efforts by the Government of Zimbabwe to access resources from the Green Climate Fund. The study sought to sharpen our problem definition concerning climate change risks and impacts on smallholder farmers in southern Zimbabwe. It involved desk reviews of policy instruments and an analysis of climate and hydrological trends by expert scientists. Visits to smallholder irrigation schemes in the Save, Runde and Mzingwane river basins and consultative meetings with both rain-fed and irrigated farmers and members of civil society were conducted to unearth the climate and non-climate barriers undermining resilience in the three river basins.

This study was further informed by data provided by national, provincial and local level technical government officials and development partners operating in southern Zimbabwe. Wider consultations were held with the multi-stakeholder National GCF Think Tank chaired by the Ministry of Lands, Agriculture, Water, Climate and Rural Resettlement, which provides expert opinion and technical backstopping to the government in its efforts to access the GCF.

In conclusion, I wish to acknowledge the technical and financial support received from the United Nations Development Programme and the Climate Resilient Infrastructure Development Facility and to thank the farming communities and civil society organizations who actively participated in the Feasibility Study consultations.

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**Minister of Environment, Water and Climate**

*Please note:* The Ministry of Environment, Water and Climate was the ministry responsible for climate resilience at first submission of the Feasibility Study, 2017. The Ministry mandated to deal with climate change later changed to Ministry of Lands, Agriculture, Water, Climate and Rural Resettlement, end of 2018, and the Feasibility study has been updated to reflect this change. The foreword has been maintained as is.

## ***Executive Summary***

This Feasibility Study is an assessment of key climate change risks and impacts to water security and agricultural productivity and presents possible interventions to improve the climate resilience of vulnerable smallholder farmers in the Save, Runde and Mzingwane river basins in southern Zimbabwe. Zimbabwe is a low-income Southern African country with an estimated GDP of US$14.2 billion and a GNI per capita of US$840. Its economy is agro-based, with agriculture contributing on average 20% to GDP, as well as directly and indirectly to the livelihoods of approximately 70% of the rural population. The potential of the agriculture sector is constrained by impacts of climate variability and change, which are characterized by rising temperatures, increasing rainfall variability, regularly punctuated by El Nino effects, and increasing extreme events in frequency and intensity, such as droughts and mid-season dry spells. These climate change risks are threatening the livelihoods of the poorest communities in southern areas of Zimbabwe, who practice predominantly rain-fed agriculture. Impacts will include a reduction in water availability in these regions, which are already water scarce, and degrading ecosystems and agricultural lands. Due to its heavy dependence on rainfall, decreasing and more erratic precipitation significantly affects the agriculture sector, which negatively impacts the GDP of the country. A significant determinant of Zimbabwe's ability to improve economic growth and reduce poverty and inequality is its ability to adapt agricultural-based livelihoods to the adverse impacts of climate change.

Climate change projections indicate Zimbabwe will experience an increase of average annual temperature and evapotranspiration, which together with reduced rainfall, and decreasing runoff, will significantly impact water availability for agriculture. This will shift cropping patterns and degrade ecosystems and agricultural lands. Southern Zimbabwe, comprising the three river basins of Save, Runde and Mzingwane and the administrative provinces of Manicaland, Masvingo and Matebeleland South, accounts for 3.9 million people and about 45% of the rural population. This area is expected to experience more significant climate impacts than the rest of the country, with rainfall projected to decrease by 12-16% and a proportional greater decline in runoff by 2050 for Mzingwane and Runde catchments[1]. According to a World Bank analysis, farmers in this area will be unable to grow rain-fed maize under climate change, even the current drought tolerant varieties. This has direct consequences for the food and income security of 3.9 million people. Given the dependency of the poorest communities on water supply for their livelihoods, the impacts of climate change are jeopardising the food and income security of an already vulnerable population. It is estimated that a 2.5°C temperature increase can cause a decrease in net farm revenue by USD 400 million. A 7 to 14% precipitation decrease would result in a decrease in farm revenue of USD 300 million.

The Government of Zimbabwe has invested significantly in increasing smallholders' adaptive capacities, as seen in the Zimbabwe Agricultural Investment Plan (ZAIP) (2013-2018) and the Public Sector Irrigation Programme (PISP) (2013-2017), and has made significant progress in mainstreaming climate change into national development planning, as evidenced by the National Climate Change Response Strategy (2014) and the National Climate Policy (2017). Many development partners and initiatives have complimented such efforts, such as the Zimbabwe Resilience Building Fund (ZRBF), UNDP/GEF, USAID, FAO and DFID. Interventions have focused on increasing smallholders' climate resilience through supporting adoption of climate resilient agriculture (CRA) practices, irrigation, market linkages, climate information services and institutional coordination. However, there remain gaps in service delivery to smallholders to increase their capacities, resources and information access in climate risk management, and efforts have not considered all elements of a holistic, climate resilience approach to achieve transformational change, at scale.

In recognition of the need to promote smallholders' climate change adaptation and achieve a paradigm shift in the way land and water resources are managed in the face of an evolving climate, the Ministry of Lands, Agriculture, Water, Climate and Rural Resettlement (MLAWCCR) established a Think Tank, comprised of a multi-sectoral team of climate change experts from government, civil society, the private sector and research institutions, to spearhead the process of identifying and developing projects to submit for funding to the Green Climate Fund (GCF). This included mobilising a team of consultants to conduct this study, involving rigorous desk reviews of policy instruments and an analysis of climate and hydrological trends. A series of Sub-assessment reports have been undertaken to investigate key gaps and possible intervention areas in detail. Between September 2015 and August 2017, 147 meetings and consultations with government officials, NGOs and other resource persons were conducted and field visits to 35 rain-fed and irrigated farming communities, of which 29 were irrigation schemes, have taken place to develop the project idea. A particular focus has been coordination with key donors operating in the region, to build synergies with existing investments and prevent overlap and duplication. Regular progress meetings have been held with the Think Tank, UNDP and the Climate Resilient

1 [1] Climate change and water resources planning, development and management in Zimbabwe : main report, Davis, R. and Hirji,R. (2014) World Bank

Infrastructure Development Facility (CRIDF), an initiative funded by DFID, operating in the region. The study makes recommendations on how smallholder farming systems in southern Zimbabwe can be made resilient in the face of climate change, on the basis of best practices and lessons learned from past and on-going projects, and identifying gaps and barriers to implementation. These are underpinned by three recommended implementation principles to achieve transformational change. A **holistic** approach, **framed by climate risk analysis**, is recommended as the key implementation principle. This encourages institutional collaboration and multi-stakeholder consultation, as it is based on the understanding that building climate resilience requires a variety of different components and multiple stakeholders to work together. Further, an '**end user-centric**' approach should be employed, to place community participation and ownership at the centre of interventions. Valuable indigenous knowledge is a key information source that should be used to inform investments. Finally, a '**market-development'** approach is recommended to act as the driver of an 'exit strategy' for the project. Opportunities provided by private sector engagement have the potential to lift smallholders out of poverty and promote micro-small enterprises and, overtime, a vibrant rural economy. As climate change risks and impacts are gendered, the project also needs to analyse how interventions can contribute to gender-equal opportunities for food security and income generation for smallholders. How to improve the role of women as business entrepreneurs should be a central area in this approach.

The study recommends interventions in the following areas to build smallholders' adaptive capacities in the Save, Runde and Mzingwane river basins: a) climate resilient agricultural production, through: climate resilient agriculture (CRA), expanded irrigation, and market linkages, b) climate information services, and c) institutional coordination and knowledge management. Implementation of all elements, collectively, will build climate resilience.

The project should increase smallholders' climate resilient agricultural production by up-scaling the adoption of **Climate resilient agriculture** (CRA) across the southern provinces, through the roll out of tailored, site-specific CRA packages in Farmer Field Schools, for rain-fed (crop and livestock) and irrigated farming communities. The project should also invest in 21 **climate resilient irrigation** schemes to achieve sustainable and effective water supply in the face of increasing climate risks, powered by solar, when viable. This will provide farmers with diversification options into climate resilient, higher-value crop and livestock livelihood combinations. Horticulture, sesame, small grains, sorghum, and livestock production should be promoted, as they are crop-livestock combinations that are climate resilient, have an unmet demand in the market and offer opportunities for gender empowerment. The capacity building of key institutions, such as AGRITEX and DoI, and Irrigation Management Committees and farmers associations at the local level, will ensure farmers are supported in increasing agricultural production and sustaining irrigation and water efficiency investments. To encourage the adoption of CRA practices and technologies *at scale,* the project should promote **market linkages** between smallholders and private companies, to leverage private sector investment into climate resilient smallholder agriculture production. This should be done through the establishment of **multi-stakeholder Innovation Platforms**, working in tandem with Farmer Field Schools, to provide a platform for market stakeholders to address climate risks and work collaboratively to find innovative solutions to overcome production and marketing challenges. Training in 'farming as a business' should be provided to farmers and institutionalised across the extension service, to encourage the development of micro-small enterprises and rural entrepreneurs, overtime.

Farmers will also benefit from more accurate and dependable **climate information**, to allow planning of agricultural tasks in the face of climatic changes. The project should support establishment of a fully functioning **climate information system,** both in installing infrastructure to increase the coverage network of climate information collection and build the capacity of MSD, AGRITEX and ZINWA to release climate advisories to smallholders in southern Zimbabwe, for them to address climate risks in their livelihood strategies.

A **national coordination mechanism** for climate change adaptation and resilience building efforts in agriculture should be established, building on existing frameworks, to coordinate multiple stakeholders across government and non-government entities, including private sector partners. The network of Innovation Platforms should be used to feed learning into this mechanism and influence policy decision-making. Knowledge management systems should be invested in supporting adoption, best practice, and scale-up of CRA practices and the development of market linkages in value chains. Agricultural Training Colleges and DR&SS research stations should be supported to function as centres of excellence that may provide improved knowledge management and training in climate resilient agricultural livelihoods, including CRA and 'farming as a business', to AGRITEX Extension Officers and smallholders.

The **sustainability** of proposed interventions can be assured by: a) ensuring participation of all stakeholders in activities, predominantly through Innovation Platforms, b) building upon existing and local institutional structures, c) promoting learning, adaptive management and knowledge dissemination through Farmer Field Schools, Innovation Platforms, and DR&SS research stations and Agriculture Training Colleges, d) a climate resilient, sustainable approach to irrigation investment that ensures uptake of O&M costs by communities, and e) a market driven approach, leveraging further private sector investment.

**Abbreviations and Acronyms**

| | |
|---|---|
| AGRITEX | Department of Agricultural, Technical and Extension Services |
| AIDS | Acquired Immune Deficiency Syndrome |
| ARC | Agricultural Research Council |
| ARDA | Agricultural Rural and Development Authority |
| AEWs | Agricultural Extension Workers |
| AWS | Automatic weather stations |
| BRICS | Brazil, Russia, India, China and South Africa |
| CA | Conservation agriculture |
| CAADP | Comprehensive African Agriculture Development Programme |
| CALESA | Climate Analogue Locations in Eastern and Southern Africa |
| CGIAR | Consultative Group on International Agricultural Research |
| CMD | Climate Change Management Department |
| COMESA | Common Market for Eastern and Southern Africa |
| CRIDF | Climate Resilience Infrastructure Development Facility |
| CRA | Climate resilient agriculture |
| CIAT | International Centre for Tropical Agriculture |
| CIMMYT | Centro Internacional de Mejoramiento Maiz y Trigo/International Maize and Wheat Improvement Centre |
| CTA | Technical Centre for Agricultural and Rural Co-operation |
| DAEO | District Agricultural Extension Officer |
| DOI | Department of Irrigation |
| DR&SS | Department of Research and Specialist Services |
| EMA | Environmental Management Agency |
| FANPARN | Food, Agriculture and Natural Resources Policy Analysis Network |
| FAO | Food and Agriculture Organisation |
| FNC | Food and Nutrition Council |
| GCF | Green Climate Fund |
| GDP | Gross Domestic Product |
| GEF | Global Environmental Facility |
| GESI | Gender Equality and Social Inclusion |
| GHG | Greenhouse Gas |
| GMB | Grain Marketing Board |
| GNI | Gross National Income |
| HIV | Human immunodeficiency virus |
| HPC | National High Performance Computer |
| ICRISAT | International Crops Research Institute for the Semi-Arid Tropics |
| IFAD | International Fund for Agricultural Development |
| IMC | Irrigation Management Committee |
| IWMI | International Water Management Institute |
| INDCs | Intended Nationally Determined Contributions |
| IPPC | Intergovernmental Panel on Climate Change |
| LA | Landscape Approach |
| LEDS | Low Emission Development Strategy |
| LPD | Livestock Production and Development |
| MEI | Maize Equivalent Income |
| MFTP | Master Farmer Training programmes |
| MLAWCCR | Ministry of Lands, Agriculture, Water, Climate and Rural Resettlement |
| MSD | Meteorological Services Department |
| NAMAs | Nationally Appropriate Mitigation Actions |
| NAPAS | National Action Plan for Adaptation |
| NEPAD | New Partnership for African Development |
| NGOs | Non-Governmental Organisations |
| PAEO | Provincial Agricultural Extension Officer |
| RSOP | River Systems Outline Plans |
| PRSP | Poverty Reduction Strategy papers |
| REDD | Reducing Emissions from Deforestation and Forest Degradation in Developing Countries |
| SADC | Southern African Development Community |
| SMME | Small Micro and Medium Enterprises |
| SMS | Short Messaging Service |

| | |
|---|---|
| SWC | Soil and Water Conservation |
| UK | United Kingdom |
| UN | United Nations |
| UNDP | United Nations Development Programme |
| UNFCCC | United Nations Framework Convention on Climate Change |
| USAID | United States International Development Agency |
| UZ | University of Zimbabwe |
| ZAIP | Zimbabwe Agricultural Investment Plan |
| ZANU PF | Zimbabwe African National Union Patriotic Front |
| ZESA | Zimbabwe Electricity Supply Authority |
| ZRBF | Zimbabwe Resilience Building Fund |
| ZIMASSET | Zimbabwe Agenda for Sustainable Socio- Economic Transformation |
| ZINWA | Zimbabwe National Water Authority |
| ZRBF | Zimbabwe Resilience Building Fund |

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# 1 Introduction and background

## 1.1 Objectives of the feasibility study

This feasibility study was carried out as part of the development of the proposed Green Climate Fund project to support climate resilience of vulnerable agricultural livelihoods in Southern Zimbabwe.

The feasibility study seeks to identify existing and predicted climate vulnerabilities and determine the priorities for building resilience for vulnerable agricultural livelihoods in the Southern part of Zimbabwe. It establishes the baseline data for the intervention to identify the most suitable strategy for building resilience and to recommend concrete actions for the national, subnational and community level.

## 1.2 Structure of the feasibility study

The feasibility study provides a climate risk profile and vulnerability analysis for Zimbabwe in chapter 1 to inform the geographic targeting and selection of strategic interventions for the proposed project.

The following chapters 2-4 provides the baseline in terms of policy and institutional frameworks, the past and ongoing efforts to improve agricultural livelihoods, the gaps in service delivery and associated barriers. Chapter 5 presents an analysis of best practice and lessons learnt which informs the subsequent suggestions for the design and structure of the project. Chapter 6 further details concrete recommendations for the outputs and activities to be included in the proposed Green Climate Fund project, largely based on and summarising the detailed findings from four sub-assessments (available as separate and stand-alone sub-annexes) which are listed in Table 1, and which provided detailed support for project design, site analyses, local community needs, and climate-related vulnerabilities. Chapter 6 also provides an overview of costs associated with each activity.

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| Annex II | Feasibility Study |
| Annex II(a) | Climate Resilient Irrigation in Southern Zimbabwe - Mzingwane, Runde and Save River Basins |
| Annex II (b) | Agricultural Value Chain Identification and Analysis |
| Annex II (c) | Climate-smart agriculture packages |
| Annex II (d) | Inclusive Finance and Risk Insurance |

Table 1: Four sub-assessments undertaken in support of the project design, detailed site analyses, local stakeholder needs and assessment of climate-related vulnerabilities.

## 1.3 Process and methodology of the feasibility study

In recognition of the need to build climate resilience in the agriculture and water sectors to increase the adaptive capacity of smallholders, in September 2015, the Ministry of Lands, Agriculture, Water, Climate and Rural Resettlement (MLAWCCR) established a Think Tank, composed of a multi-sectoral team of climate change experts from GoZ, civil society, private sector, academia and research institutions. The Think Tank was tasked to spearhead the process of identifying and developing projects the country could submit for funding to the Green Climate Fund (GCF) and other financing windows. The Think Tank has been guided by government policies on climate change, agriculture and water (see Chapter 2).

From September 2015, the following activities were undertaken to develop this project:

- Various and continuous consultations with government officials, donor organisations, private companies, research institutions, NGOs/implementation partners to build on and synergise with other investments;
- Meetings and validation workshops between the Think Tank, the Climate Resilience Infrastructure Development Facility (CRIDF), a DFID-funded water infrastructure facility working in southern Zimbabwe, and the United Nations Development Programme (UNDP) also operating in the country, to present feedback and progress;
- Interviews, Focus Group Discussions and field visits to rain-fed and irrigated farming communities, where consultations with farmers and key stakeholders, such as provincial and district level AGRITEX Extension Officers and provincial irrigation engineers, were undertaken. Key informant interviews involving farmers and CSOs were based on interviews with the leadership of the selected communities in the presence of other farmers (where they were available), during data collection. These farmers were encouraged to participate in the discussions, an approach which yielded rich insights into the vulnerabilities and challenges faced by farmers;

- Interviews with senior government officials, which included directors and senior members of departments at national headquarters, who provided further guidance on ideas for the proposal.

Visiting teams to communities were comprised of officials from the Climate Change Management Department and Department of Water Resources Management in the Ministry of Lands, Agriculture, Water, Climate and Rural Resettlement (MLAWCCR), Department of Irrigation (DOI) and Department of Agricultural, Technical and Extension Services (AGRITEX) in the Ministry of Lands, Agriculture, Water, Climate and Rural Resettlement, as well as CRIDF and UNDP consultants. The schemes and communities were chosen by DOI, in collaboration with AGRITEX, based on climate vulnerability assessments and potential opportunities, as well as having limited donor activity to both prevent duplication of efforts and identify potential co-financing.

A Concept Note and Pre-feasibility Study were formally submitted to the GCF by the Zimbabwe National Designated Authority (NDA) in September 2016. Having received positive feedback, work progressed into full Proposal and Feasibility Stage. This involved further field work, focusing on conducting more farmer consultations, and in-depth analysis to resolve gaps identified by the Pre-feasibility Study through the commissioning of Sub-assessment reports. Community consultations and Focus Group Discussions (FGDs) were conducted for all Sub-assessment Reports and by the proposal development team between September 2016 and June 2017, with a focus on conducting women's FGDs where possible. The following areas were explored in more detail by the Sub-assessments, the findings of which are summarised in this Feasibility Study:

- Irrigation design and solar PV viability analysis;
- Value chain analysis;
- Inclusive finance and risk insurance assessment; and
- Climate resilient agriculture packages analysis.

In addition to these sub assessments, a climate information systems analysis was carried out and fed directly into the development of this feasibility study. A gender analysis and action plan was developed and is attached to the proposal.

The findings of each Sub-assessment have been validated in presentations to the Think Tank and through continuous engagement with MLAWCCR and key departments in MLAWCCR and MLAWCCR. The main donors and programmes operating in the country, namely ZRBF, DFID, UNDP, FAO and IFAD, and research institutes including ICRISAT, were engaged in the targeting and intervention design, to capitalise on lessons and share best practices. Donor engagement has been particularly pertinent to build on baseline investments and facilitate synergies in both intervention focus and geographical targeting, preventing duplication of effort. Also, UNDP and MLAWCCR have met with donors and projects working with similar focus to discuss potential co-financing. A total of 147 government officials, resource persons and NGO's were consulted from end 2015 to September 2017. In total, 7 Think Tank Meetings were carried out. A total of 35 farming communities were visited, of which 29 were irrigation schemes.  (See a detailed list of consultations and stakeholders consulted in annex to the full proposal.

## 1.4 Country socio-economic context, geography and challenges affecting smallholder crop production

Zimbabwe is a landlocked Southern African country that is 390,757 km² in size with a population of 14.5 million[2,3]. Its population is projected to increase to 20.6 million by 2050 and 22.1 million by 2080[4], and its administrative structure is comprised of eight rural and two urban provinces. Each province is comprised of districts, with 60 rural districts in total; each district is further comprised of a number of wards. Since attaining national independence in 1980, it has maintained a multi-party political system and has run scheduled national and local government elections, the most recent of which were in 2018. Zimbabwe is, furthermore, a participating member of the Southern African Development Community (SADC)[5].
Zimbabwe is a **low-income** country with an estimated Gross Domestic Product (GDP) of US$31 billion and Gross National Income (GNI) per capita of US$1,790[6], and ranks 156 out of 187 countries in the Human Development

[2] MLAWCCR. 2013.  ZAIP. A comprehensive framework for the development of the agricultural sector. Harare, Zimbabwe.
[3] https://www.cia.gov/library/publications/the-world-factbook/geos/zi.html
[4] Record Meteo. 2016. Projected population for Zimbabwe. Available on: http://www.recordmeteo.com/population/population-zimbabwe-en-23129.html (Accessed 15 June 2016)
[5] http://www.sadc.int/
[6] World Bank. 2016. Zimbabwe. Available on: http://data.worldbank.org/country/zimbabwe (Accessed 9 Oct 2019)

Index[7,8]. **Sixty seven percent of the population live in rural areas, where there is widespread poverty** [9,10]. **Southern areas are home to 3.9 million people (45% of the rural population) and some of the poorest communities in the country**, with poverty prevalence across the Southern provinces ranging from 66-74%[11] Matabeleland South (44%), Masvingo (50%) and Midlands (48%) provinces had the highest proportions of food insecure households at peak hunger period in 2016, exceeding the national average of 42%[12].

## 1.5 Climate risk profile of Zimbabwe

### *1.5.1 Climate and agro-ecological zones*

Climatic conditions are largely subtropical. A distinct feature of the country's climate is a prolonged dry season of 7-8 months (April to October) and a short rainy season of four months (mid-November to mid-March)[13,14]. Zimbabwe's planting season traditionally begins in October/November, and the harvest season starts from around March/April. The heaviest rains usually fall in December, often with short, sharp storms and mid-season droughts experienced in January, and drizzly rain (perfect for crops) in February, before the dry season starts again (April to October; Zimbabwe's winter and spring). Average annual temperatures range from 23ºC in the southern areas (Lowveld) to 18ºC in the northern (Highveld) parts of the country.

Zimbabwe is classified into five **Agro-Ecological Regions (AERs) depicting agricultural potential,** according to rainfall, temperature and soil patterns[15] (Figure 1). AER I, II and III comprise of areas with high potential for agriculture and livestock production; whilst both rainfed and irrigated crops are grown these regions have the greatest percentage of rainfed systems due to higher rainfall (> 650mm per annum)[16]. AERs IV and V are the semi-arid areas in south and north western Zimbabwe, covering about 64% of the country. They have the lowest agricultural potential for rain fed agriculture (though not for irrigated agriculture), largely because they are characterised by a higher risk of seasonal droughts and severe mid-season dry spells during the rainy season[17,18,19]. Additionally, much of the land designated for communal and smallholder farming is situated in the south with access to limited water resources, presenting smallholders with challenging farming conditions. Zimbabwe is, furthermore, expected **to suffer increases in temperature, rainfall variability and the frequency and intensity of extreme events under climate change**[20,21].

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[13] UNDP. 2014. Scaling Up Adaptation. Project Document. UNDP Environmental Unit.
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[19] Ibid.
[20] IPCC. 2014. Fifth IPCC Report. Climate Change 2014: Impacts, Adaptation, and Vulnerability. Chapter 22. Africa. IPCC Geneva, Switzerland.
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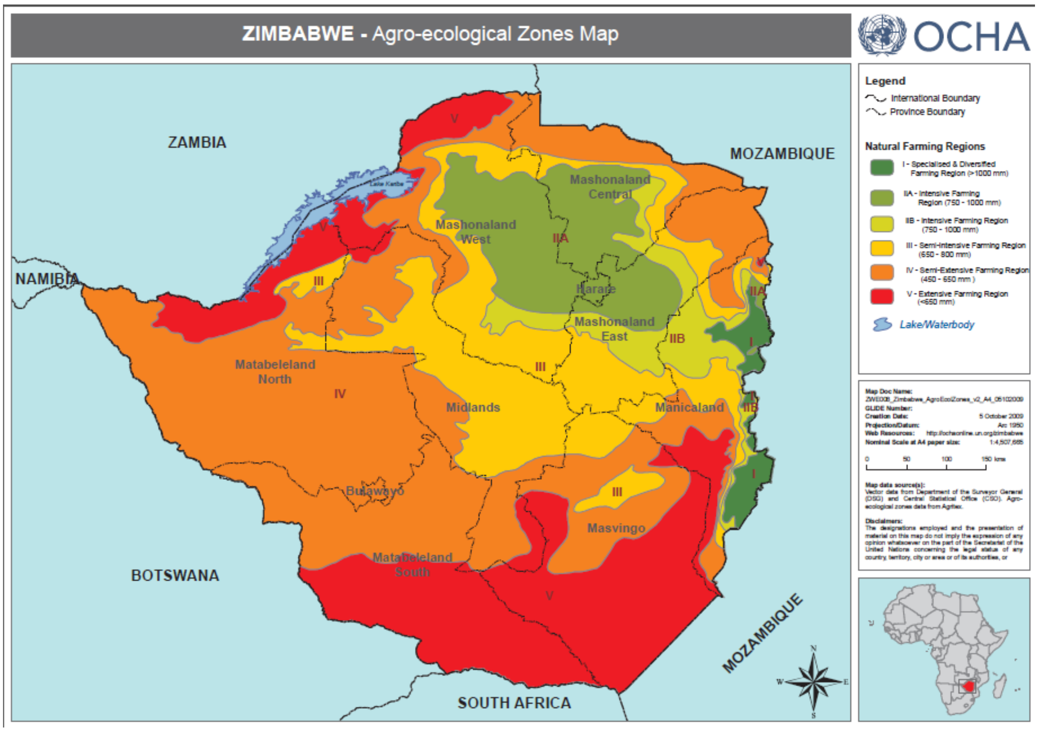


Figure 1: Agro-Ecological Regions of Zimbabwe. Regions IV and V are drought prone with < 650mm rainfall per annum.

*Source: OCHA*

### *1.5.2 Climate impacts on the economy*

Zimbabwe continues to experience a **deteriorating economic context**. The country suffered its greatest annual decline in GDP after the financial crisis of 2008 and a prolonged period of hyperinflation[22]. This has resulted in the worsening quantity and quality of basic services and infrastructure, affecting the rural poor most profoundly, and leading to the collapse of the rural economy. Economic growth grew slightly between 2009 and 2011, mainly because of price stability due to the introduction of a multi-currency system in 2009, but decreased from 2011 to 2015, from 11.9% to 1.5%, and more than halved to 0.5% in 2016[23,24]. The **financial sector** is characterised by low liquidity and non-performing loans[25]. Credit is increasingly difficult and expensive to acquire, particularly affecting the rural poor who have traditionally not received financial services. The **private sector** is best described as fragmented, as it recovers from sharp economic decline, spurred on by a ban on fresh produce imports[26]. The majority of the rural population are excluded from **formal value chains** and participate in inefficient informal markets, such as informal municipal markets[27,28]. Furthermore, the country is a net importer of food, and in 2015 bought one million tons of maize, mainly from Zambia[29].

**The economy's overdependence on natural resources has contributed to its contraction in recent years**. The agricultural sector accounts for 20% of GDP[30,31]; it is the largest single source of export earnings (estimated at

[22] IFAD. 2016. Republic of Zimbabwe. Smallholder Irrigation Revitalisation Programme. Detailed Design Report. East and Southern Africa Division. Programme Management Department.
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[26] African Economic Outlook. 2017. Available on: http://www.africaneconomicoutlook.org/en/country-notes/zimbabwe (Accessed 5 May 2017)
[27] Value Chain Analysis Sub-assessment.
[28] The total value added contributed by the informal sector in Zimbabwe is US$1,256.8 million, with US$446.7 million from households engaged in agricultural activities. *Source:* ZIMSTAT. 2013. Poverty Income Consumption and Expenditure Survey 011/2012 Report. ZIMSTAT and UNDP Harare.
[29] CESVI. 2017. Country Case Study: Zimbabwe. CESVI.
[30] United Nations. 2014. Zimbabwe Country Analysis: Working Document, 3 October 2014. Available on: www.zw.one.un.org (Accessed 1 December 2015).
[31] Anseew, A. Kapuya, T., and Saruchera, D. 2012. *Zimbabwe's agricultural reconstruction: Present state, ongoing projects and prospects for investment.* Development Planning Division Working Paper Series No. 32. Development Bank of Southern Africa, Johannesburg.

40%)[32]; it contributes between 25% and 30% to formal employment[33]; and accounts for 60% of raw materials for the country's largely agro-based industries[34]. The main agricultural exports include tobacco, raw sugar, horticultural crops, coffee, tea and cotton[35,36]. Due to its heavy dependence on rainfall, a reduction in precipitation has been shown to negatively affect GDP[37]. Reduced rainfall often occurs during the negative phase of El-Nino Southern Oscillation (ENSO) events (El Nino) and was the basis for some of the first seasonal forecasts of rainfall and maize yield[38]. **Agriculture is also the basis of the direct and indirect livelihoods of almost 70% of the population**, with most smallholder farmers depending on rain fed agriculture[39]. Smallholders in rural areas (of which 70% are women[40]) grow predominantly rain-fed maize (the staple food crop) for subsistence on small plots of land, usually between 1 and 4 ha[41]. Other crops grown for consumption and local sale include millets, groundnuts, pumpkins and sweet potatoes, and a small proportion of cash crops such as cotton, soybeans and tobacco are grown and sold in predominantly local formal markets mostly for export[42]. If the rainy season is not effective or their water sources have depleted (i.e. rivers and boreholes have dried up), smallholders are often forced to practice 'stream-bed cultivation' (planting crops in river-beds), which contributes to increased siltation and erosion in river-beds. Water shortages continue to be a development priority for communities: 22.4 percent of sampled communities prioritised improvement of water and sanitation, irrigation, dam construction and rehabilitation (the highest proportion of all development priorities identified)[43].

**In 1995, Zimbabwe was categorised as water stressed. Projections indicate it will be water scarce by 2025**[44]. A recent World Bank study (2014) pointed to significant decreases in mean annual precipitation as well as mean annual runoff under both a business as usual and an ecologically emissions scenario – most notably affecting the catchments in the Southern part of the county[45]. The country shares nine transboundary river basins with its neighbours and has seven river catchments inside its borders: Gwayi, Manyame, Mazowe, Mzingwane, Runde, Sanyati and Save. Recognising the importance of water to economic development and poverty reduction, GoZ has invested in thousands of large, medium and small dams for urban and rural supply and sanitation and irrigation, although many are not suitable for small scale irrigation in the rural setting (see Annex 1 for distribution of dams and Annex 2 for an overview of water resources)[46]. The country ranks second to South Africa within SADC with respect to per capita water storage, despite a severe lack of water availability in rural areas, particularly in the semi-arid southern areas[47].

### *1.5.3 Poverty and agricultural livelihoods*

Due to the country's colonial history, **the bulk of smallholders practice farming, predominantly rain-fed maize production, in the lowest agricultural potential areas of AERs IV and V** (Figure 1)[48]. Mean annual

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[32] Ibid.
[33] Kapuya T, Saruchera D, Jongwe, A, Mucheri, T, Mujeyi, K, Ndobongo, LT & Meyer, FH, 2010. *The grain industry value chain in Zimbabwe.* Unpublished draft prepared for the Food and Agricultural Organization (FAO). Available on: www.fao.org/fileadmin/templates/est/AAACP/ eastafrica/UnvPretoria_GrainChainZimbabwe_2010_1_.pdf (Accessed 18 June 2016)
[34] Mudimu, G, 2003. *Zimbabwe Food Security Issues Paper.* Forum for Food Security in Southern Africa. London: Overseas Development Institute (ODI). www.odi.org.uk/ projects/03-food-security-forum/docs/ZimbabweCIPfinal.pdf, accessed 24 January 2011.
[35] Harvard Economic Atlas. 2014. Zimbabwe Agricultural Exports. Available on: http://atlas.cid.harvard.edu/ (Accessed 5 May 2017)
[36] United Nations. 2014. Zimbabwe Country Analysis: Working Document, 3 October 2014. Available on: www.zw.one.un.org (Accessed 1 December 2015).
[37] MWRDM. 2012. Water resources development and management background paper: Towards a water secure Zimbabwe: Improving governance and utilisation of water resources, Background paper for the National Water Policy for Zimbabwe. GoZ, Harare.
[38] Cane, M. A., Eshel, G., & Buckland, R. W. (1994). Forecasting Zimbabwean maize yield using eastern equatorial Pacific sea surface temperature. *Nature*, *370*(6486), 204–205. https://doi.org/10.1038/370204a0
[39] Anseew, A. Kapuya, T., and Saruchera, D. 2012. *Zimbabwe's agricultural reconstruction: Present state, ongoing projects and prospects for investment.* Development Planning Division Working Paper Series No. 32. Development Bank of Southern Africa, Johannesburg.
[40] Brown, D., et al. 2012. Climate change impacts, vulnerability and adaptation in Zimbabwe. IIED Climate Change Working Paper No. 3.
[41] Manzungu, E. et al. 2016. (Draft) Potential impacts of Climate Change and Adaptation Options in Zimbabwe's Agricultural Sector. World Bank.
[42] Manzungu, E. et al. 2016. (Draft) Potential impacts of Climate Change and Adaptation Options in Zimbabwe's Agricultural Sector. World Bank.
[43] ZimVAC. 2014. Zimbabwe Vulnerability Assessment Committee 2014 Rural Livelihoods Assessment. SIRDC. ZimVAC, Harare
[44] Hirji, R. and Molapo, J. 2002. Environmental sustainability in water resources management: A conceptual: framework, In: R. Hirji, P. Johnson, P. Maro, and T. Matiza-Chiuta, (eds.) *Defining and Mainstreaming Environmental Sustainability in Water Resources Management in Southern Africa.* SADC, IUCN, SARDC, World Bank: Maseru/Harare/Washington DC..1-20.
[45] Davis, R. and R. Hirji. 2014. Climate Change and Water resource Planning, Development and Management in Zimbabwe. An Issues Paper. World Bank.
[46] Davis, R. and R. Hirji. 2014. Climate Change and Water resource Planning, Development and Management in Zimbabwe. An Issues Paper. World Bank.
[47] Manzungu, E. 2011. Reviving irrigation development and management. Thematic Paper 3 Background paper on Water resources development and management for the Zimbabwe National Water Policy, Harare, Zimbabwe.
[48] Nyabako, T. and E. Manzungu. 2012. An Assessment of the Adaptability to Climate Change of Commercially Available Maize Varieties in Zimbabwe. Environment and Natural Resources Research. 2(1), pp. 32-46.

precipitation in AER V can be as low as 300mm, and is characterised by high variability[49]. The Length of the Growing Period (LGP) (determined by heat and water)[50] is, on average, very low in these regions, at 60-135 days, with only the most eastern parts of the country reaching above 160 days (Figure 2)[51]. Most of the southern regions are less than 120 days on average and year to year variability is high; only two out of every four or five agricultural seasons is a good year in terms of rainfall for the current choice of crops and growing methods[52]. Additionally, there is evidence that climate change is shortening the LGP (see section 1.6.3 below), which will significantly increase the risk of crop failures in southern regions where it is already close to critical thresholds for growing maize[21].

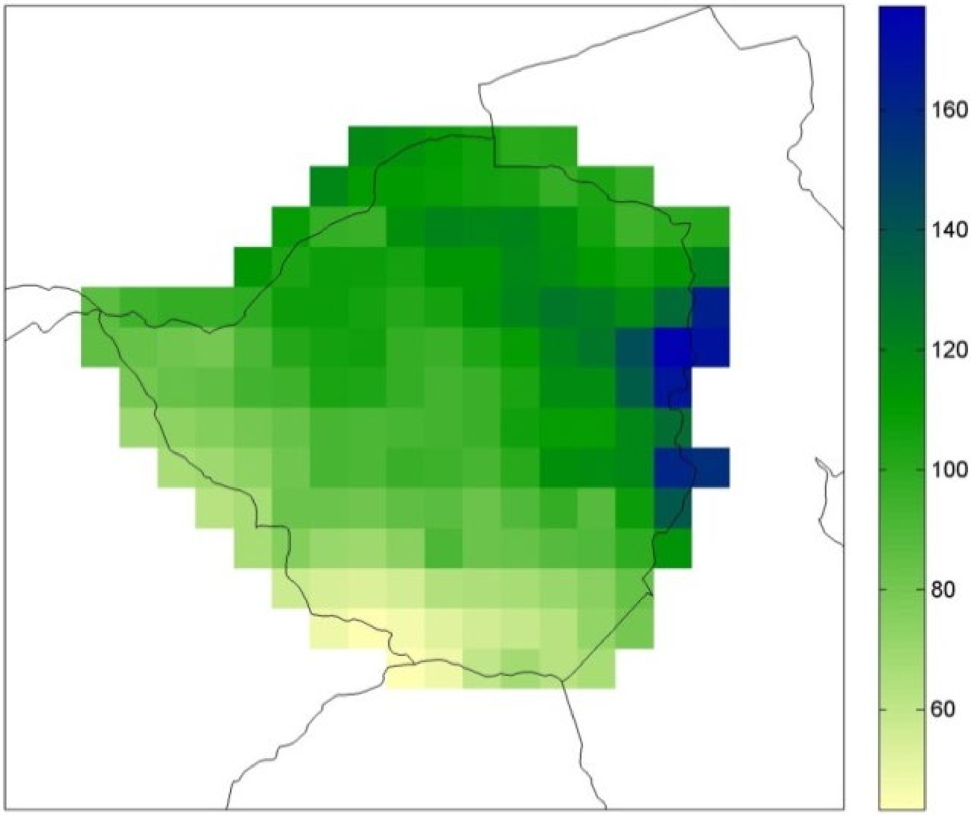



Figure 2: Historical Length of Growing Period (LGP) in days.

*Source: World Bank*

Communities in AERs IV and V live predominantly on communal lands[53,54,55]. Settlements are mainly concentrated near rivers and in scattered villages inland where some water is available from natural pools and springs[56]. Across this area, smallholders practice a diverse range of crop and livestock combinations and strategies, comprising of rain-fed crop production systems, livestock production systems and mixed crop-

[49] Davis, R. and R. Hirji. 2014. Climate Change and Water resource Planning, Development and Management in Zimbabwe. An Issues Paper. World Bank.

[50] The number of days where agricultural conditions (heat and water) are suitable for growing crops in a season.

[51] Manzungu, E. et al. 2016. (Draft) Potential impacts of Climate Change and Adaptation Options in Zimbabwe's Agricultural Sector. World Bank.

[52] Nyamudeza, P. 1999. Agronomic practices for the low rainfall regions of Zimbabwe. In: Manzungu, E., Senzanje, A., and van der Zaan P. (Eds.) *Water for agriculture: Policy and management options for the smallholder sector,* Harare: University of Zimbabwe Publications, 49-63.

[53] 74% of communal land in the country falls in AERs IV and V. *Source*: UNDP. 2014. Scaling Up Adaptation. Project Document. UNDP Environmental Unit.

[54] The other land categories in the agricultural sector are commercial and resettlement areas.

[55] Communal lands are defined as land in rural areas owned on a usufruct basis based on customs, conventions and norms of a particular ethnic group. Each household has the right to a piece of farmland, a residential plot and access to common grazing land. *Source:* Holleman, J.F. 1952. Shona Customary Law: With Reference to Kinship, Marriage, the Family and the Estate (Manchester University Press). *In:* CESVI. 2017. Country Case Study: Zimbabwe. CESVI.

[56] CESVI. 2017. Country Case Study: Zimbabwe. CESVI.

livestock production systems (see Annex 3 for an overview of crop-livestock livelihood strategies in the southern provinces)[57]. They have traditionally managed risk by diversification of crops and income sources. Due to a lack of available water resources and soil moisture, many smallholders are increasingly practicing ‘stream-bed’ and ‘in-stream’ cultivation (planting in stream and river beds), an unsustainable farming practice that contributes to erosion and siltation of water resources and the degradation of ecosystems[58]. Crop yields are extremely low and the risk of crop failure is high in one out of three years[59]. The majority of communal farmers do not have access to irrigation – only about 10,000 ha out of the 180,000 ha of irrigated land is found on communal lands, which represents 5% by area and less than 1% by demography[60].

## 1.6 Climate change in Zimbabwe: observed and projected climate variability and change

The Fifth IPCC Assessment Report shows that **warming over land** across Africa has increased by 0.5-2°C over the past 50–100 years[61]. Projections indicate that by 2100, mean surface temperature changes across the African regions will be in the range of 2.5 to 5.8°C, compared to 1990 levels[62]. Surface temperatures in Southern African have risen by 0.5°C on average over the past 100 years and further increases at a rate of 0.05°C per decade are expected. Projected increases are greatest on arid and semi-arid margins, particularly in southwest Africa. Temperatures are also expected to rise more during the dry season of June to November, peaking during the already hottest time of year before the rains break. Projected changes in rainfall suggest decreases in annual rainfall over parts of Southern Africa, with the arid and semi-arid regions expected to receive the largest decreases. Inter-annual rainfall variability has increased since the late 1960s, and extreme events have become more intense and frequent[61].

### *1.6.1 Climate change and observed climate trends*

Given the country’s agro-based economy and majority rural population almost entirely dependent on rain-fed crop and livestock production, Zimbabwe is highly vulnerable to the impacts of climate change. This section presents observed and projected changes to variables important for agricultural production, namely: temperature, precipitation and extreme events. While there are a number of studies on climate change in Zimbabwe, data recorded below is largely GoZ-adopted information, as captured in the National Climate Change Response Strategy (NCCRS) (2014), which informed the National Water Policy (NWP) (2017).

In terms of area and historical coverage, there is a limited number of synoptic, agrometeorological and rainfall-only weather observation stations in Zimbabwe. The number of available stations is further limited for those reporting temperature and especially in the southern and eastern regions where stations sometimes do not report for significant periods of time.To observe/provide evidence of historical climate changes, a limited data set of reliable observed data was obtained for the target region from the Zimbabwe Meteorological Services Department (MSD). These data were quality controlled using the RClimdex software[63], taking care to remove data when:

- Negative and extremely high (>200mm) daily rainfall values;
- Sequences of similar temperatures > 15 days;
- Negative temperatures when stations not in mountains;
- Minimum temperatures >= maximum temperatures.

The same software was used to calculate the WMO-standard ETCCDI set of 27 extreme rainfall and temperature related indices[64]. The metadata for the 23 stations used in the analysis can be found in Table 2 below (all stations have data from 1st January 1971 until 31st December 2018). Only those stations highlighted in yellow have daily minimum and maximum temperature data.

| Station | Longitude | Latitude | Altitude |
|---|---|---|---|

[57] UNDP and ZRBF. 2016. Mapping of Selected Hazards Affecting Rural Livelihoods in Zimbabwe: A District and Ward Analysis. ZRBF, Harare.
[58] CRIDF (2017) Sub Assessment: Climate Resilient Irrigation in southern Zimbabwe - Mzingwane, Runde and Save River Basins
[59] Nyabako, T. and E. Manzungu. 2012. An Assessment of the Adaptability to Climate Change of Commercially Available Maize Varieties in Zimbabwe. Environment and Natural Resources Research. 2(1), pp. 32-46.
[60] Manzungu, E. 2011. Reviving irrigation development and management. Thematic Paper 3 Background paper on Water resources development and management for the Zimbabwe National Water Policy, Harare, Zimbabwe.
[61] IPCC. 2014. Fifth IPCC Report. Climate Change 2014: Impacts, Adaptation, and Vulnerability. Chapter 22. Africa. IPCC Geneva, Switzerland.
[62] IPCC. 2014. Fifth IPCC Report. Summary for policy makers. Climate change 2014. Synthesis report. IPCC. Geneva, Switzerland.
[63] https://rdrr.io/github/rodneychan-ec/RClimDex/man/RClimDex.html
[64] http://etccdi.pacificclimate.org/indices_def.shtml

| | | | |
|---|---|---|---|
| Beitbridge | 30 | -22.1 | 457 |
| Bikita | 31.72 | -20.07 | 1020 |
| Bufallo Range | 31.58 | -21.02 | 433 |
| Buhera | 31.43 | -19.32 | 1192 |
| Bulawayo Goetz | 28.62 | -20.15 | 1358 |
| Chipinge | 32.62 | -20.2 | 1131 |
| Chisengu | 32.88 | -19.88 | 1480 |
| Chivhu | 30.88 | -19.03 | 1459 |
| Esigodini | 28.95 | -20.35 | 1160 |
| Gweru | 29.85 | -19.45 | 1424 |
| Kadoma | 29.88 | -18.32 | 1183 |
| Kezi | 28.45 | -20.92 | 1020 |
| Kwekwe | 29.83 | -18.93 | 1220 |
| Makoholi | 30.78 | -19.83 | 1204 |
| Masvingo | 30.87 | -20.07 | 1075 |
| Matopos | 28.5 | -20.38 | 1370 |
| Mutare | 32.67 | -18.98 | 1120 |
| Mvuma | 30.52 | -19.28 | 1406 |
| Plumtree | 27.8 | -20.48 | 1387 |
| Rusape | 32.13 | -18.53 | 1405 |
| Wedza | 31.57 | -18.62 | 1532 |
| West Nicholson | 29.37 | -21.05 | 860 |
| Zvishavane | 30.07 | -20.32 | 975 |

Table 2: Weather station locations and altitude available for the southern and eastern regions for the period 1971-2018. Stations highlighted in yellow have minimum and maximum daily temperature data.

Where possible, the following was established for each station:

- Annual and seasonal rainfall calculated at each station;
- Extreme indices for rainfall and temperature for each station;
- Annual and seasonal indices for both potential evapotranspiration (PET) and rainfall-PET, to highlight the impact of increases in evapotranspiration and reduced effective rainfall which can lead to drier soils and potentially less runoff for rivers.

Note that indices were only calculated if all rainfall data during the averaging period (seasonal and annually) was recorded for all days. Trends were only calculated for stations with indices spanning 10 years or more, using a Thiel-Sen implementation in R and bootstrapping to determine the 95% confidence interval. This procedure allows the disaggregation of trends based on geographical locations and provides guidance on how the climate of Zimbabwe has been changing between 1971 and 2018.

### *1.6.2 Temperature trends*

#### *1.6.2.1 Observed temperature trends*

Since 1950, Zimbabwe has been experiencing more hot and fewer cold days[65]. The country's annual mean surface temperature has warmed by about 0.4ºC from 1900 to 2000, with the national average maximum temperature increasing by about 1ºC over the same period[66]. The increase in mean temperatures has been experienced especially during the dry season, with minimum temperatures increasing more rapidly than maximum temperatures[67]. Daily minimum and maximum temperatures have risen by approximately 2.6°C and 2°C

[65] GRID Arendal. 2017. Climate change in Zimbabwe: trends in temperature and rainfall. Available on: http://www.grida.no/resources/7034 (Accessed 5 May 2017)
[66] KAS. 2015. Climate Change in Zimbabwe: Facts for Planners and Decision Makers. Author: Brazier, A. Konrad-Adenauer-Stiftung.
[67] MENRM. 2013. Zimbabwe Climate Change Response Strategy. Available on: www.ies.ac.zw/downloads/draft%20strategy.pdf (Accessed 18 June 2016)

respectively over the last century[68]. The period from 1980 to date has been the warmest on record and it is estimated that October 2015-February 2016 was the driest, or second driest, period on record for large areas of Southern Africa, including Zimbabwe[69].

Evidence for the character of observed temperature increases in the station data for southern Zimbabwe is presented in Figure 3. Of the 5 stations with temperature data, 4 indicate positive trends in minimum daily temperature (statistically significant at 2 stations), with one station (Chipinge) in the east indicating a negative trend (Figure 3a). All 5 stations, however, indicate positive and statistically significant trends in maximum daily temperatures, indicating that days have become significantly hotter since 1971 (Figure 3b). This observation is confirmed by positive trends in the numbers of days above 35°C at 4 stations (2 statistically significant) - Figure 3c. Given that maximum temperatures are more consistently increasing than minimum temperatures the diurnal temperature range has also been statistically significantly increasing at 4 of the 5 stations (Figure 3d).

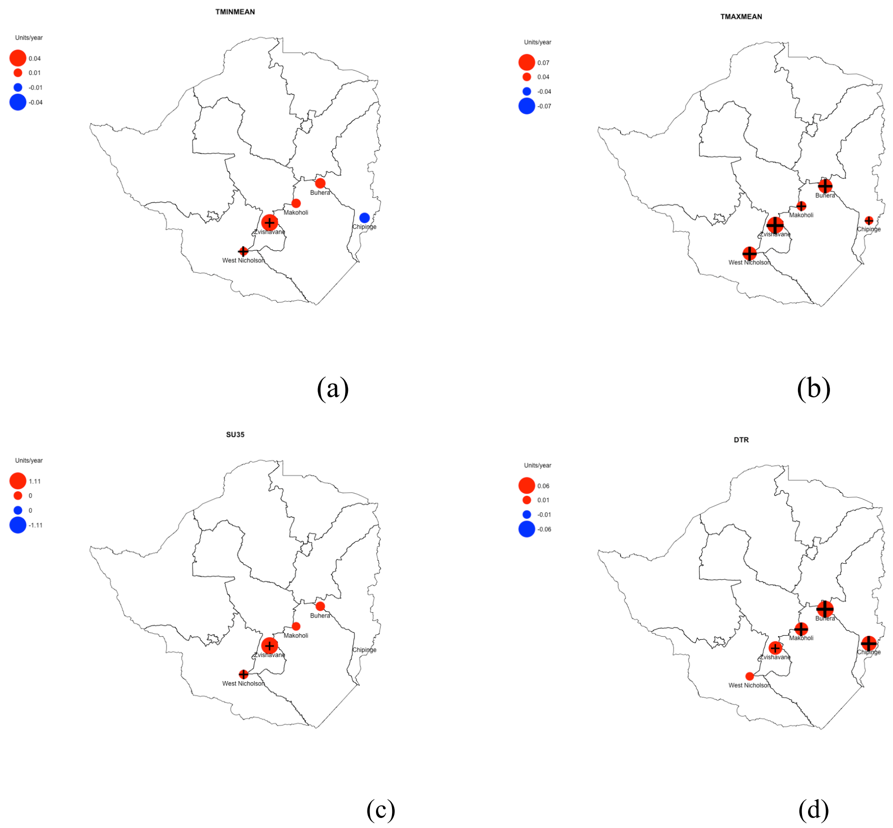



Figure 3: Observed trends (1971-2018) in annual mean daily minimum temperature (a), maximum temperature (b), days maximum temperature > 35°C; and (d) diurnal temperature range. "+"/"-" symbols indicate +ve/-ve trends respectively significant at the 95% confidence interval.

### *1.6.2.2 Projected temperature trends*

Projections anticipate warming rates of 0.5–2$^{0}$C by 2030, 1–3.5$^{0}$C by 2070, and 3–4$^{0}$C by 2100 (all across the 1961-1990 baseline), assuming an A2 greenhouse gas emissions pathway[70,71]. This is consistent with the World Bank Climate Change Knowledge Portal's future scenarios projection, which predicts an increase in average

[68] Makarau, A. 1999. Zimbabwe's climate: Past, present and future. *In:* Manzungu, E., Senzanje, A., and van der Zaag, P. (eds.) Water for agriculture in Zimbabwe: Policy and management options for the smallholder sector. Harare, University of Zimbabwe Publications, pp.3-16.
[69] FEWS NET . 2016. Southern Africa Special Report. Illustrating the extent and severity of the 2015-16 drought. Available on: http://www.fews.net/southern-africa/special-report/march-2016 (Accessed 1 July 2016)
[70] Engelbrecht, F and Bopape, M.J. 2009. Projections of Future Climate Change over Southern Africa. CSIR Natural Resources and the Environment Atmospheric Modelling.
[71] KNMI. 2006. Climate Change Scenarios. KNMI, The Netherlands.

annual temperature of between 3ºC and 4ºC from 2020-2099, relative to actual records for 1980-1999 (Figure 4)[72]. These scenarios suggest a warming rate of just below 0.2$^{0}$C per decade to over 0.5$^{0}$C per decade.

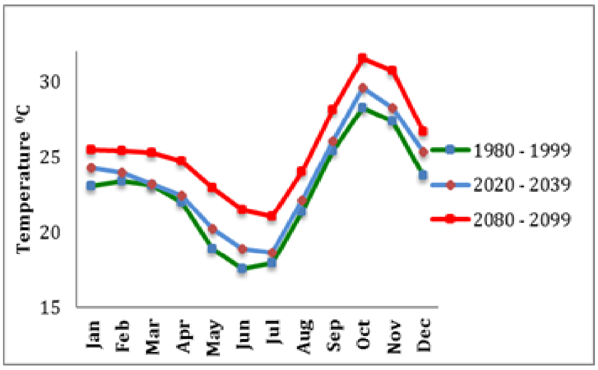



Figure 4: Comparison of actual [1980-1999] and projected [2020-2039 and 2080-2099] annual mean temperatures in Zimbabwe.

*Source: World Bank Climate Change Knowledge Portal*

Further evidence for the expected continued increases in temperature are found in the suite of GCMs used to simulate the representative concentration pathways (RCPs) under the CMIP5 archive used as part of the IPCC 5th assessment report. The data from these GCMs have been made available through a newly constructed facility by the Swedish Meteorological and Hydrological Institute (SMHI) as part of WMO provided support for improving the climate rationale in GCF proposals[73]. Figure 5 clearly indicates expected increases of between 1.4 and 3.6°C, with the highest expected (mean) changes of 3.5°C during October before the rainy season when farmers are preparing fields and waiting for the rains. This has serious implications for evaporation and soil moisture as shown below.

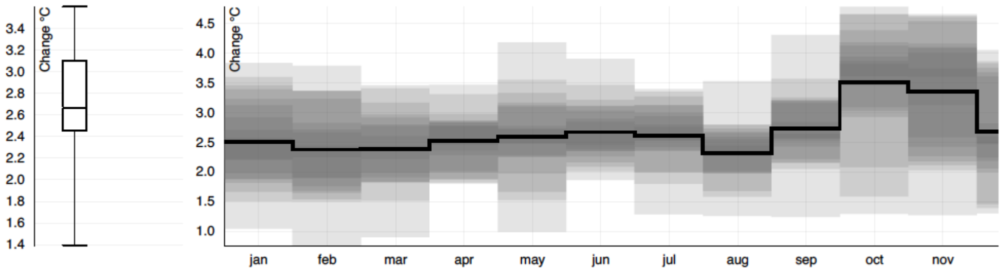



Figure 5: Mean (solid line) and GCM model spread (shading) of projected increases in temperature for southern Zimbabwe under RCP 8.5 (2041-2070). Left hand side range of projected annual mean changes.

### *1.6.3 Changes in precipitation, evapotranspiration and effective rainfall*

#### *1.6.3.1 Observed precipitation trends*

The total amount of rainfall has declined by 5% since the start of the 20th century, and has exhibited **considerable spatial and temporal inter-annual variability** (Figure 6: Zimbabwe precipitation trend 1901-2010.

*Source: MSD*). In later years these changes have been accompanied by a late onset of rains, increases in the frequency and intensity of heavy rainfall events (and decreases in low intensity rainfall events) and increases in the proportion of low rainfall years[74,75].

[72] World Bank. 2013. Climate Change Knowledge Portal for Development Practitioners and Policy Makers. Available on: http://sdwebx.worldbank.org/climateportal/index.cfm?page=country_future_climate&ThisRegion=Africa&ThisCcode=ZWE (Accessed 1 July 2016)
[73] https://climaterationale.org/
[74] Unganai, L. 1996. Historic and future climatic change in Zimbabwe. Climate Research. Vol. 6: 137-145.
[75] Eriksen S. 2008. Climate Change in Eastern and Southern Africa: Impacts, Vulnerability and Adaptation. University of Oslo, Oslo.

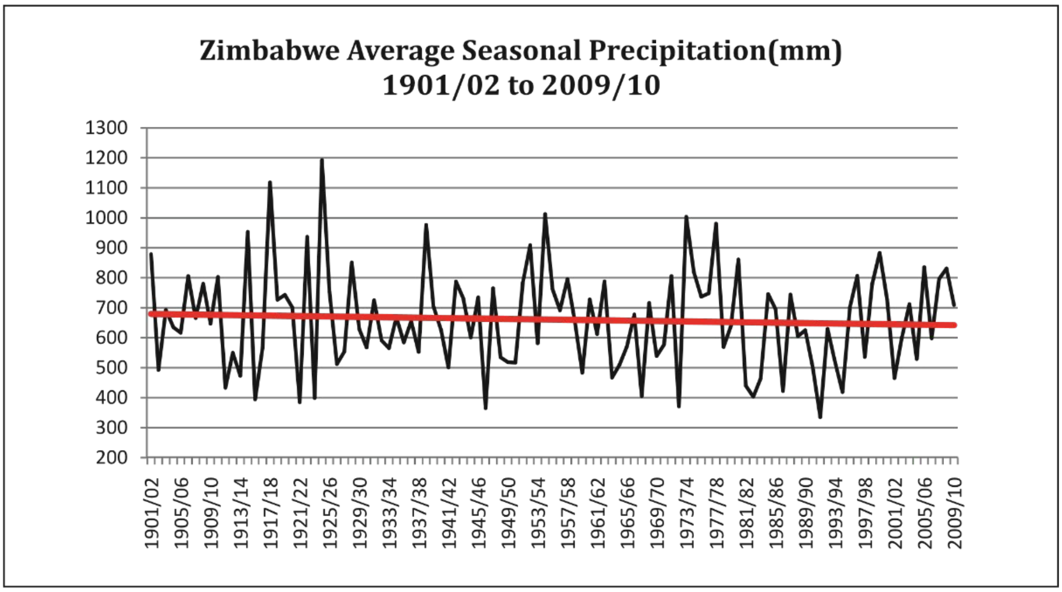
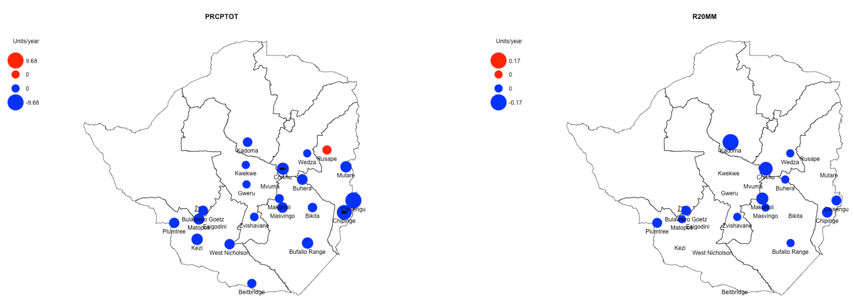


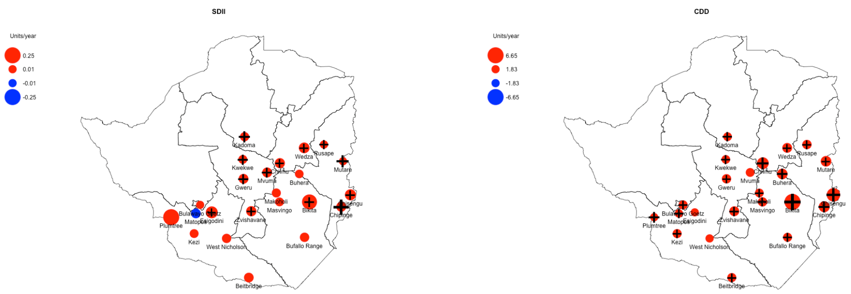

Figure 6: Zimbabwe precipitation trend 1901-2010.

*Source: MSD*

Given the observed decline in annual rainfall it is useful to assess how these trends have manifested spatially and seasonally over the last 40-50 years. Utilising the 23 stations for which daily rainfall data were available, Figure 7a clearly shows that total annual rainfall has declined at all stations except Rusape between 1971 and 2018. Furthermore, Figure 7b indicates that this trend is accompanied by reductions in rainfall events > 20mm (also seen in similar plots for events > 10mm) indicating that there have been a reduction in low intensity rainfall days. Conversely Figure 7c indicates that there have been widespread statistically significant increases in the average intensity of rainfall falling on a rainday, suggesting that rainfall has on average become more intense i.e there is a shift from low intensity to high intensity events. This is accompanied by widespread statistically significant increases in the maximum consecutive number of dry days, which either indicates that the length of the dry season has got longer, or that dry spells within the rainfall season have increased, both of which are detrimental to agricultural production. Increases in the length of the dry season are consistent with a later onset, earlier cessation and a shortening of the rainy season, which in southern regions is already close to critical thresholds for growing maize the main staple. A shortening of the rainy season on average will increase the risk of seasons being to short to grow maize, especially late maturing varieties which are preferred for taste and nutrition[21]. Increases in the length of dry spells within the season are also a well-known cause of crop failure (see section 1.7.1.1 below), particularly during January and February when the crop is most vulnerable.




(a) (b)




(c) (d)

Figure 7: Observed trends (1971-2018) in annual rainfall (a); daily rainfall events > 20mm (b); average intensity of rainfall on a day with rain (c); and maximum number of consecutive dry days (d). "+"/"-" symbols indicate +ve/-ve trends respectively significant at the 95% confidence interval.

Further evidence for daily rainfall intensities increasing since 1971 are provided in Figure 8 (left), which shows that , except for 3 stations, annual maximum 1-day rainfall has on average been increasing. This also seen, though less consistently (6 stations have negative trends) in increases in the number of days where rainfall is greater than the 95$^{th}$ percentile rainfall event (Figure 8, right). Together with the evidence in Figure 7 these trends suggest that average rainfall intensities have been increasing and this is manifested at many stations by increases in the maximum and higher percentiles of rainfall intensities, attributes of rainfall most directly associated with flooding and in particular flash floods, which damage irrigation infrastructure.

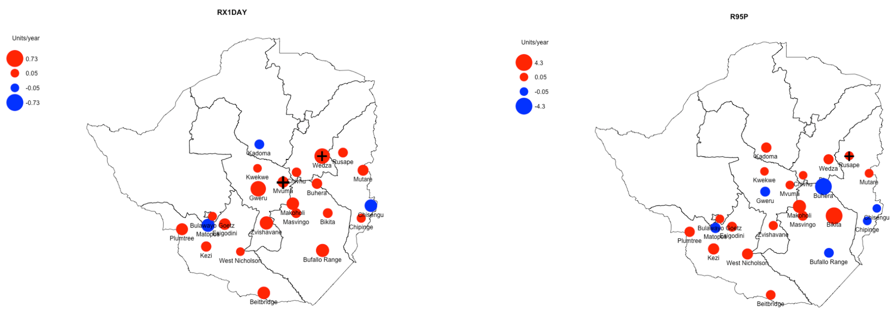



Figure 8: Trends (1971-2018) in annual maximum 1 day rainfall (left) and number of days rainfall intensity > 95$^{th}$ percentile rain event (right). "+"/"-" symbols indicate +ve/-ve trends respectively significant at the 95% confidence interval.

Figure 9 shows the same trends for individual seasonal total rainfall. Whilst the core of the rainfall season during DJF (Figure 9a) indicates both +ve and -ve trends (all insignificant), with no clear spatially coherent changes, both JJA (winter/dry season) and SON (early rainfall season) indicate consistent and in many cases statistically significant decreases in rainfall. Whilst these seasons are not the core rainfall season they are important agriculturally; some areas cultivate winter crops such as winter wheat, and the early rains during SON are used to plant early in order to reduce the risk of early cessation of rains where the seasonal duration is close to critical thresholds[76] (a risk which may be increasing as MAM rainfall is decreasing in many areas - Figure 9c). It is also clear that less rain during these seasons when evaporative demand is high, reduces the amount of soil moisture available for land preparation and later planting.

[76] Tadross. M, P. et al. 2008. Growing-season rainfall and scenarios of future change in southeast Africa: implications for cultivating maize. Climate Research: Integrating analysis of regional climate change and response options. Vol. 40, pp.147-161.

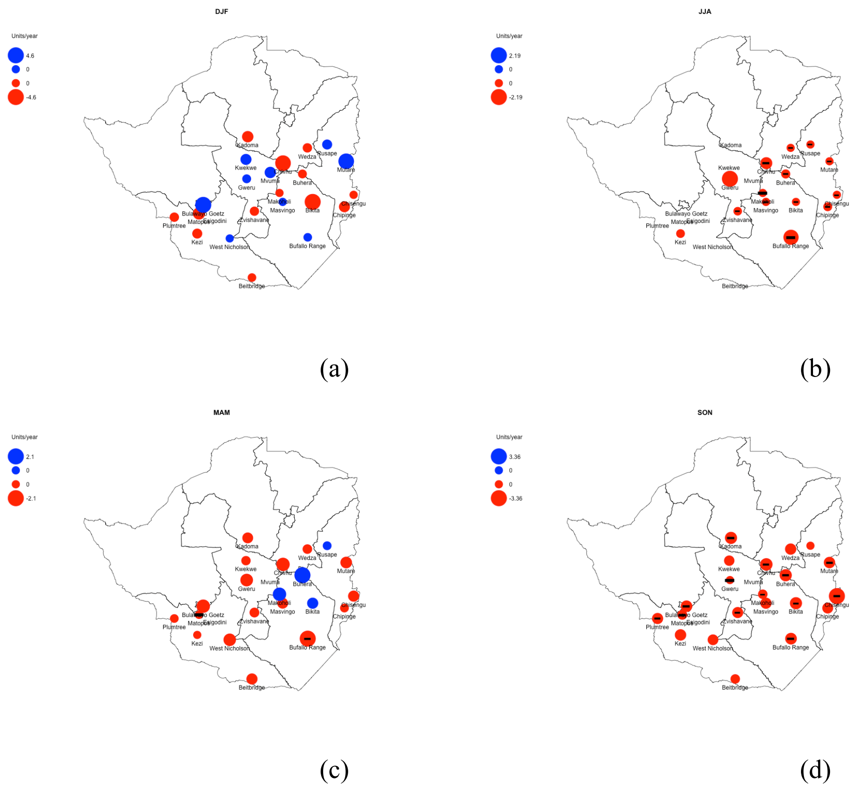



Figure 9: Observed trends (1971-2018) in total seasonal rainfall: (a) DJF; (b) JJA; (c) MAM; (d) SON. "+"/"-" symbols indicate +ve/-ve trends respectively significant at the 95% confidence interval.

### *1.6.3.2 Observed trends in evapotranspiration and adjusted rainfall*

At each individual station the daily timeseries of rainfall (P), daily minimum ($T_{min}$) and daily maximum ($T_{max}$) temperatures were used to calculate an 'adjusted rainfall', which represents the net moisture flux at the soil surface and is calculated as P-$ET_0$, where $ET_0$ is the potential evapotranspiration. There are several methods for calculating $ET_0$ from weather station data and the most suitable approach depends on the variables and timeframes for which meteorological data is available (see review by deLobel et. al, 2009[77]). Ideally the Penman Monteith[78] method is recommended, given access to a full suite of meteorological variables (P, $T_{min}$, $T_{max}$, relative humidity, wind speed and solar radiation), but given only access to P, $T_{min}$, $T_{max}$, we calculated $ET_0$ based on the Priestley-Taylor approximation[79], with modifications to the calculation as follows:

- calculations, including for solar radiation, follow FAO technical paper 56[78];
- Using mean air temperature instead of daily minimum and maximum temperatures results in lower estimates for the mean saturation vapour pressure. The corresponding vapour pressure deficit (a parameter expressing the evaporating power of the atmosphere) is smaller, resulting in underestimation of $ET_0$. Therefore, we use the mean saturation vapour pressure as the mean between the saturation vapour pressure at the daily maximum and minimum air temperatures[77];
- Adjustment to calculation of vapor pressure deficit based on an aridity index (Annual P/Annual $ET_0$)[80].

Daily $ET_0$ values calculated via the above methodology are subtracted from the corresponding daily values of P to give a daily timeseries of P-$ET_0$ which we term 'adjusted rainfall' and represents the amount of water available at the soil surface after evapotranspiration. If any data was missing for a particular day, P-$ET_0$ was not calculated and neither were the annual and seasonal mean for the corresponding year and season.

[77] deLobel F. (2009) Review of $ET_0$ calculation methods and software. FAO technical report. Rome, Italy. http://www.fao.org/tempref/SD/Reserved/Agromet/PET/delobel/PET_200903_delobel.pdf
[78] Allen R.G., Pereira L.S., Raes D., Smith M., (1998) Crop evapotranspiration - Guidelines for computing crop water requirements - FAO Irrigation and drainage paper 56, Rome, Italy. http://www.fao.org/3/x0490e/x0490e00.htm#Content
[79] Priestley C.H.B. and Taylor R.J. (1972) On the Assessment of Surface Heat Flux and Evaporation Using Large-Scale Parameters. Monthly Weather Review. https://doi.org/10.1175/1520-0493(1972)100<0081:OTAOSH>2.3.CO;2
[80] Castellvi F., Perez P.J., Stockle C.O., Ibanez M. (1997) Methods for estimating vapor pressure deficit at a regional scale depending on data availability. Agricultural and Forest Meteorology, Volume 87, Issue 4, 1 December 1997, Pages 243-252. https://doi.org/10.1016/S0168-1923(97)00034-8

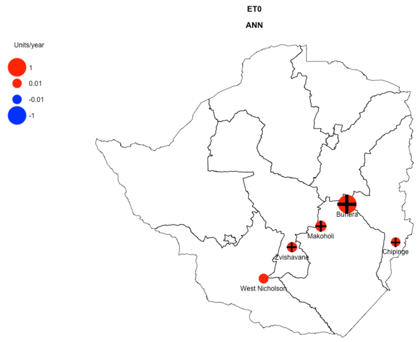
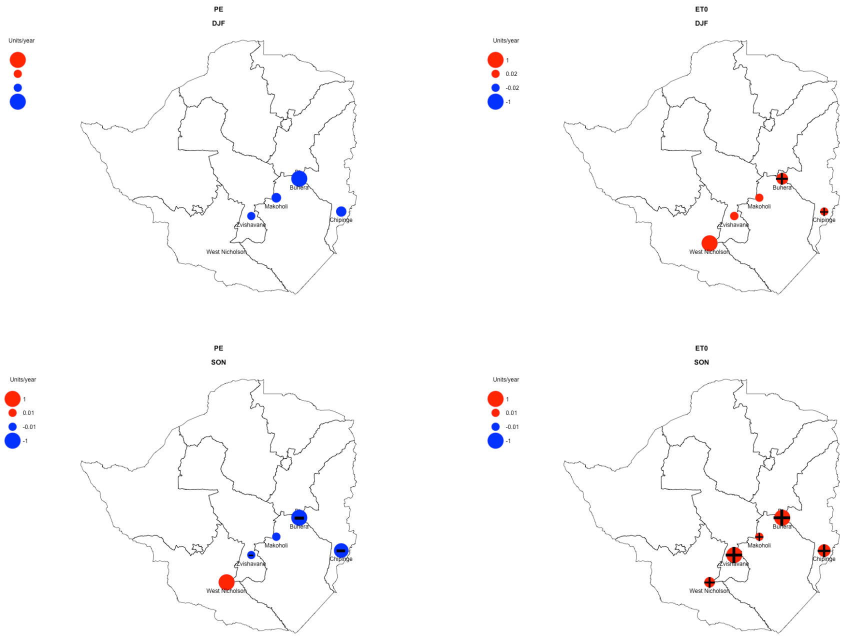



Figure 10: Observed trends (1971-2018) in annual PET. “+”/”-“ symbols indicate +ve/-ve trends respectively significant at the 95% confidence interval.

Figure 10 shows that annual PET has been increasing at all 5 stations with temperature data, significantly at 4 of them. Similarly, Figure 11 indicates that these positive trends in PET are present at all 5 stations in all seasons, with at least 2 stations significant at the 95% confidence interval in each season. The same figure also shows that besides West Nicholson during SON, all stations indicate trends for reduced adjusted rainfall (P-PET) during all seasons. Whilst this simple measure ignores changes in runoff and soil infiltration, it indicates that the climate forcing at the soil/land surface has been tending towards a reduced water influx to the land.



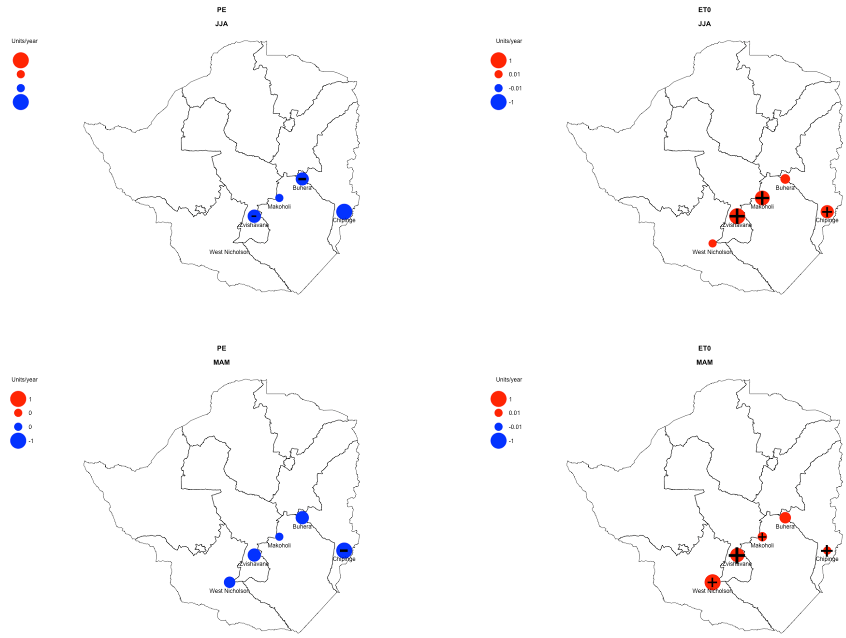



Figure 11: Observed trends (1971-2018) in seasonal PET (right) and rainfall – PET (left). "+"/"-" symbols indicate +ve/-ve trends respectively significant at the 95% confidence interval.

### *1.6.3.3 Projected changes in precipitation, aridity and water*

In the future a **decrease in rainfall** is predicted to occur in all seasons, with more consistency between model simulations for the early and late rains than for the main rainy season months of December to February[81]. **By the 2080s, annual rainfall averages are projected to be between 5% and 18% less than the 1961-1990 average.** A recent World Bank study (2014) indicates that a preliminary climate change modelling using simple methods suggests that Mean Annual Precipitation will decline, mostly in the southern Zimbabwean catchments, by up to 16% by 2050 whether or not the world succeeds in curbing greenhouse gas emissions[82]. Data from a 2016 World Bank (draft) study also indicates that rainfall is expected to become **more variable**, as an analysis of basin-level changes in precipitation to 2050 under 121 climate scenarios shows greater changes in the extreme percentiles than the mean annual data[83]. This is in agreement with the station data above which indicates that the rainy season is tending to occur later in the year, with heavier bursts of rainfall over a shorter time period and with longer mid-season dry spells, pointing to a changing seasonality[84].

According to analysis presented in the World Bank 2016 (draft) study, the following trends are predicted per river basin catchment (see Annex 4 for a more detailed analysis of the impacts of climate change on water resources in Zimbabwe):

- **By 2050 and 2080, Mean Annual Precipitation (MAP) is predicted to decrease in all catchments**, except for Manyame where it could increase slightly under the ecologically aware scenario;
- **The most affected catchments are in the south of Zimbabwe** (in Mzingwane and Runde catchments), where MAP could decline by 12-16 % by 2050 and by additional 12.25 % by 2080;
- MAP is likely to remain relatively constant in the northwest of the country (Manyame and Mazowe catchments).
- MAP could stabilize or start to recover in Gwayi, Mzingwane, Runde, Sanyati and Save between 2050 and 2080 under the ecologically aware emissions scenario, although it would continue to decline in almost all catchments if the "business as usual" emissions scenario is maintained

[81] MLAWCCR. 2013. National Climate Change Response Strategy. GoZ, Harare.
[82] Davis, R. and R. Hirji. 2014. Climate Change and Water resource Planning, Development and Management in Zimbabwe. An Issues Paper. World Bank.
[83] Manzungu, E. et al. 2016. (Draft) Potential impacts of Climate Change and Adaptation Options in Zimbabwe's Agricultural Sector. World Bank, p. 40.
[84] Magrath, J. 2015. Transforming Lives in Zimbabwe. OXFAM Case Study. OXFAM.

- Decreases in precipitation are significant at 15% in **Mzingwane catchment** by 2050 under the business as usual case, or 12% even if the world adopts ecologically aware growth patterns

These results are consistent with data provided by the SMHI portal and associated CMIP5 GCMs for southern Zimbabwe (Figure 12)[73]. The greatest percentage decreases are during late summer, winter and early spring, with average increases during the core or the rainy season (January and February). This suggests a shorter and more intense core rainy season in the future, with large reductions during spring and a later onset of the rains.

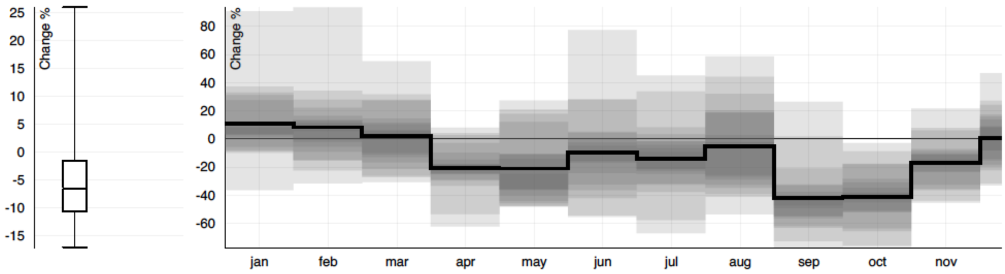
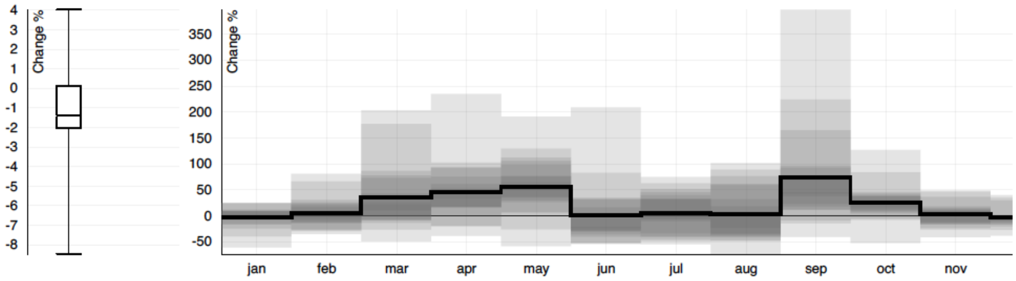
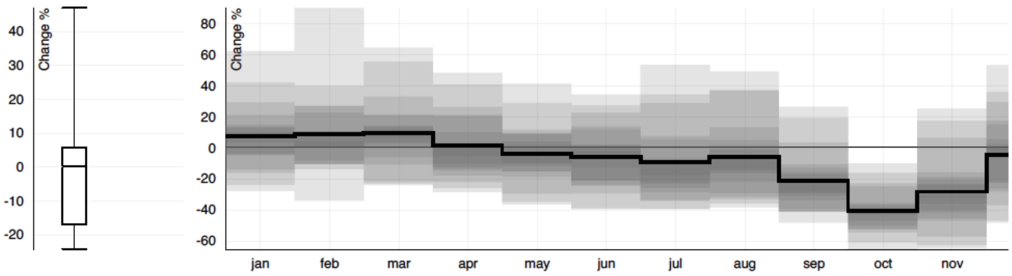



Figure 12: Mean (solid line) and GCM model spread (shading) of projected changes in rainfall for southern Zimbabwe under RCP 8.5 (2041-2070). Left hand side: range of projected annual mean changes. lat -20.86, lon 30.85.

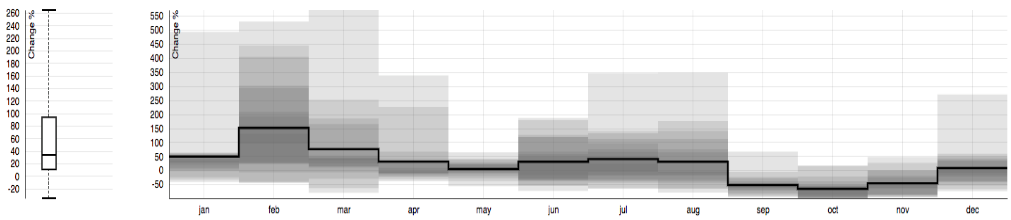
The above changes in rainfall are accompanied by an average increase of 10% in the longest dry spell (not shown) and increases in aridity (ratio of actual evapotranspiration(AET)/rainfall) – see Figure 13a. Aridity in particular increases during May and September due to a combination of increases in AET and reductions in rainfall, whereas soil moisture (Figure 13b) as a result increases during the core of the rainy season (Jan-Mar), and reduces during the rest of the year, especially during October and November at the beginning of summer and the planting season. Changes in water runoff (Figure 13c) are dependent on the catchment and location, but in general runoff increases during the core of the rainy season and reduces during spring (SON).




(a)



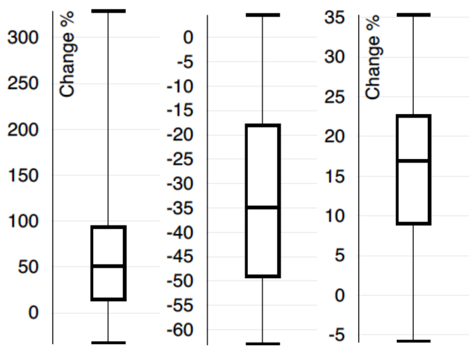

(b)



(c)

Figure 13: Mean (solid line) and GCM model spread (shading) of projected changes in: a) Actual aridity (AET/rainfall); b) soil moisture; c) water runoff, for southern Zimbabwe under RCP 8.5 (2041-2070). Left hand side: range of projected annual mean changes. lat -20.86, lon 30.85.

The changes in extreme flows suggested in Figure 13c are further verified in statistics of the annual mean maximum river discharge (Figure 14a) which for a catchment in central southern Zimbabwe is projected to increase between 15-95% (middle quartile range). The daily minimum discharge is, however, projected to decrease by 17-49% (middle quartile range - Figure 14b) and the number of days below the current annual minimum discharge is projected to increase 9-23% (middle quartile range - Figure 14c). This suggests that whilst there will be increased water availability during the core of the rainy season, there will be less than at present at other times of the year and that minimum flows will generally be less and more prevalent than at present.




(a) (b) (c)

Figure 14: Annual mean changes in: a) maximum water discharge; b) daily minima discharge; c) no of days below current annual minimum discharge. For RCP 8.5 (2040-2071), lat -20.86, lon 30.85.

### *1.6.3.4 Extreme climate events: floods and droughts*

**Extreme events** have historically adversely affected Zimbabwe, predominantly in the form of droughts, mid-season dry spells, floods and tropical storms (cyclones). The Zimbabwe Resilience Building Fund (ZRBF), a long-term initiative working with MLAWCCR to help build the country's resilience (see Chapter 3), has developed a set of hazard maps based on longitudinal data from a wide range of government and non-governmental sources and research institutions[85]. The hazard maps show that southern areas of Zimbabwe, where temperatures are higher and rainfall is lower, are highly prone to the occurrence of extreme climate events, including drought (Figure 15), mid-season dry spells (Figure 16) and floods (Figure 17).

Table 3 documents the occurrence of floods and droughts since 1990 and the number of people affected, clearly showing that drought tends to be more widespread and affect more people, whilst floods affect less people less frequently.

Table 3: Occurrence of droughts and floods in Zimbabwe between 1990 and 2015. *Source*: EM-DAT: The International Disaster Database for years 1991-2015, Zimbabwe Rapid Impacts and Needs Assessment, 2019 and the UN Zimbabwe Flash Appeal, 2019

| Disaster | Year | Number of people affected |
|---|---|---|
| Drought | 1991 | 5,000,000 |
| Drought | 1998 | 55,000 |
| Flood | 2000 | 266,000 |
| Drought | 2001 | 6,000,000 |
| Flood | 2001 | 30,000 |
| Flood | 2003 | 18,000 |
| Drought | 2007 | 2,100,000 |
| Drought | 2010 | 1,667,618 |

[85] UNDP and ZRBF. 2016. Mapping of Selected Hazards Affecting Rural Livelihoods in Zimbabwe: A District and Ward Analysis. ZRBF, Harare.

| | | |
|---|---|---|
| Drought | 2013 | 2,200,000 |
| Drought | 2015 | 1,490,024 |
| Drought | 2019 | 5,300,000 |
| Flood | 2019 | 270,000 |

This region also has high levels of other determinants of vulnerability, such as HIV/AIDS rates, crop pests and livestock diseases. Coupled with climate projections that predict increases in the frequency and intensity of extreme climate events, this makes southern areas highly vulnerable[86,87]. Furthermore, from the above records of both observed station data (and associated trends), as well as the CMIP5 projections and simulations of their impacts on aridity, soil moisture and water discharges, it is clear that the climate situation in southern Zimbabwe has already started to exacerbate these risks and will continue to do so, even without increases in vulnerability due to poverty and health considerations.

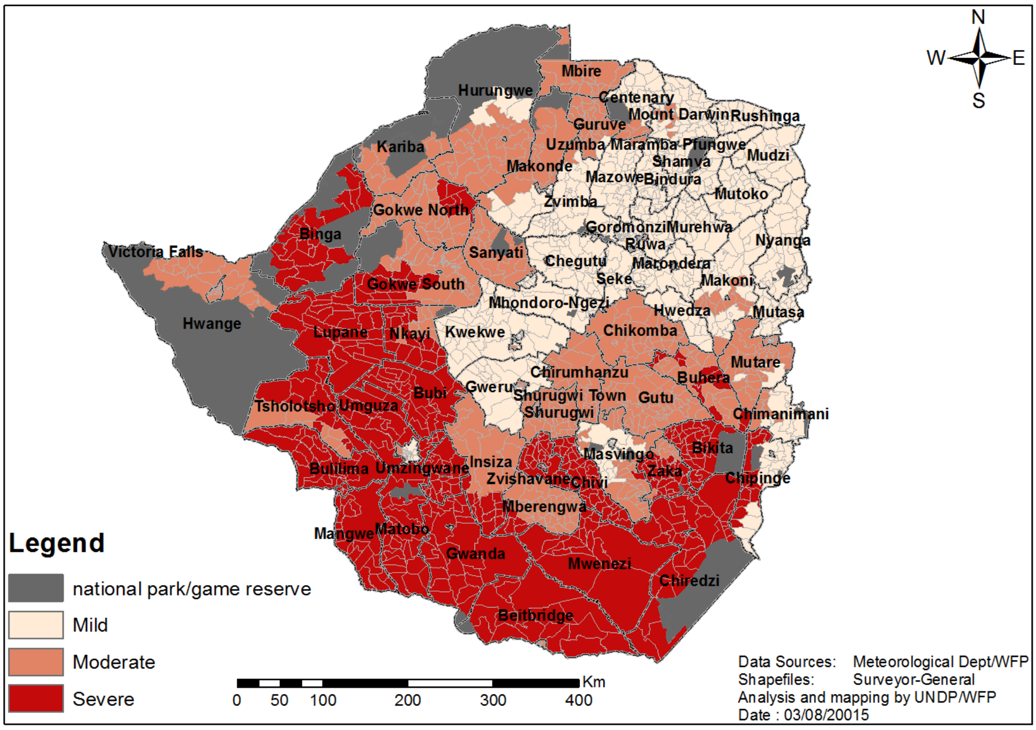



Figure 15: Risk of drought.

*Source: ZRBF*

[86] Tadross. M, P. *et al.* 2008. Growing-season rainfall and scenarios of future change in southeast Africa: implications for cultivating maize. Climate Research: Integrating analysis of regional climate change and response options. Vol. 40, pp.147-161.
[87] IPCC. 2014. Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, R.K. Pachauri and L.A. Meyer (eds.)]. IPCC, Geneva, Switzerland.

Droughts and mid-season dry spells are the most common hazards affecting rural Zimbabwe, occurring particularly in southern areas (Figure 15 and

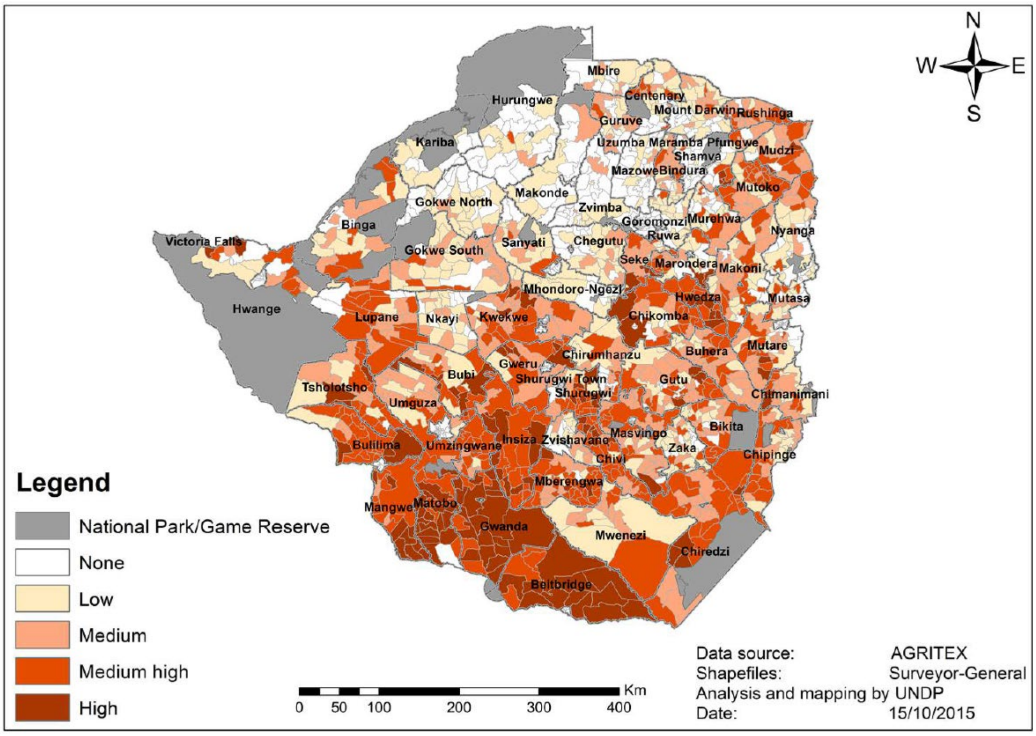



Figure 16). **Drought** has caused six of the ten worst disasters between 1991 and 2013[88]. There is a strong correlation between El Niño events and the occurrence of drought[89]. The years in which there were warm sea surface temperatures in the central and eastern Pacific (1982/83, 1986/87, 1987/88, 1991/92, 1994/95, 1997/98, 2002/03, 2004/05, 2006/07, 2009/10 and 2015/16) were all drought years in Zimbabwe and other Southern African countries[90]. **Mid-season dry spells** are defined by ZRBF as 'prolonged periods of dry weather of at least 10 consecutive days that happen after the onset of the wet season'[91]. They pose severe threats to crops that are heavily dependent on rain and without access to irrigation technology, as during these episodes crops are subject to severe heat stress, which can significantly impact yields and result in crop failure[92]. Clearly southern areas of Zimbabwe, extending to both the east and west are most at risk of droughts and mid-season dry spells the risk of which, given the historical changes in rainfall noted above (particularly noted increases in consecutive dry days), are increasing.

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[88] GoZ and UNCT. 2014. Zimbabwe Country Analysis: Working Document. Dated 4 November 2014, cited in: UNDP and ZRBF. 2016. Mapping of Selected Hazards Affecting Rural Livelihoods in Zimbabwe. A District and Ward Analysis. ZRBF, Harare.
[89] Davis, R. and Hirji, R. 2014. Climate change and water resources planning, development and management in Zimbabwe: An issues paper. Washington Dc. World Bank.
[90] Ibid.
[91] UNDP and ZRBF. 2016. Mapping of Selected Hazards Affecting Rural Livelihoods in Zimbabwe: A District and Ward Analysis. ZRBF, Harare.
[92] Kuri, F. et al. 2014. Predicting maize yield in Zimbabwe using dry dekads derived from remotely sensed Vegetation Condition Index. International Journal of Applied Earth Observation and Geoinformation. 33, pp.39-46.

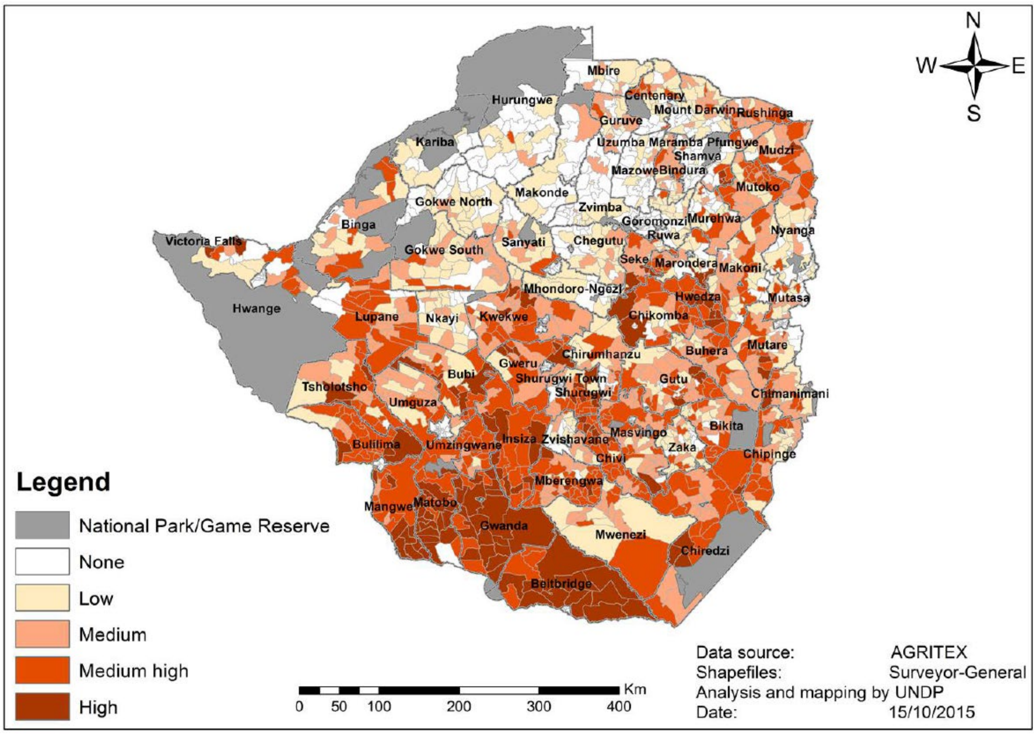


Figure 16: Risk of mid-season dry spells.

*Source: ZRBF*

**Flooding** occurs in Zimbabwe during the summer months (December to March) when the country receives most of its rain. **The most severe floods tend to be experienced in the southern and northern low-lying areas of the country** (Figure 17)[93], though it is noted that this map does not capture all flooding events (being restricted to gauged events recorded by ZinWA over a 10 year period, and not including many ungauged events particularly those due flash flooding in non-riverine areas). Both the observed increases in rainfall intensity and the projected increases in maximum water discharges shown above clearly demonstrate that flooding risks are increasing and will continue to do so in the future. Furthermore, flooding is often associated with tropical cyclones from the Indian Ocean and the accompanying high winds often cause structural damage as they track inland from the Mozambique coast. In 2002 and 2007 widespread flooding in Zimbabwe (as well as other Southern African countries), resulted in the loss of lives and livestock and extensive damage to infrastructure. In 2019, flooding resulting from Cyclone Idai left 270,000 people in need of humanitarian assistance. It is estimated that nearly 50,000 farming households were affected and that 1.4 million hectares of arable land were destroyed. Road infrastructure was destroyed, which disrupted market access. Damage to livestock, crops, food stocks and agricultural inputs was widespread. The heavy rainfall of the cyclone also resulted in soil erosion and water facilities such as dams, irrigation canals and wells suffered extensive damage or destruction. The damage to the agricultural sector was valued to US$155.3 million by the Rapid Impacts and Need Assessment (RINA). The total need for recovery across 10 key sectors was estimated at between US$557–767 million. For Cyclone Idai, the RINA notes that almost 120 mm of rain fell over a period of three days (March 15–17). The delayed start of the rainy season, followed by lower than normal rainfall created extremely dry soils dry, which prevented the torrential rainfall of Cyclone Idai from being absorbed. This exacerbated the run-off and worsened flash floods.

[93] UNDP and ZRBF. 2016. Mapping of Selected Hazards Affecting Rural Livelihoods in Zimbabwe: A District and Ward Analysis. ZRBF, Harare.

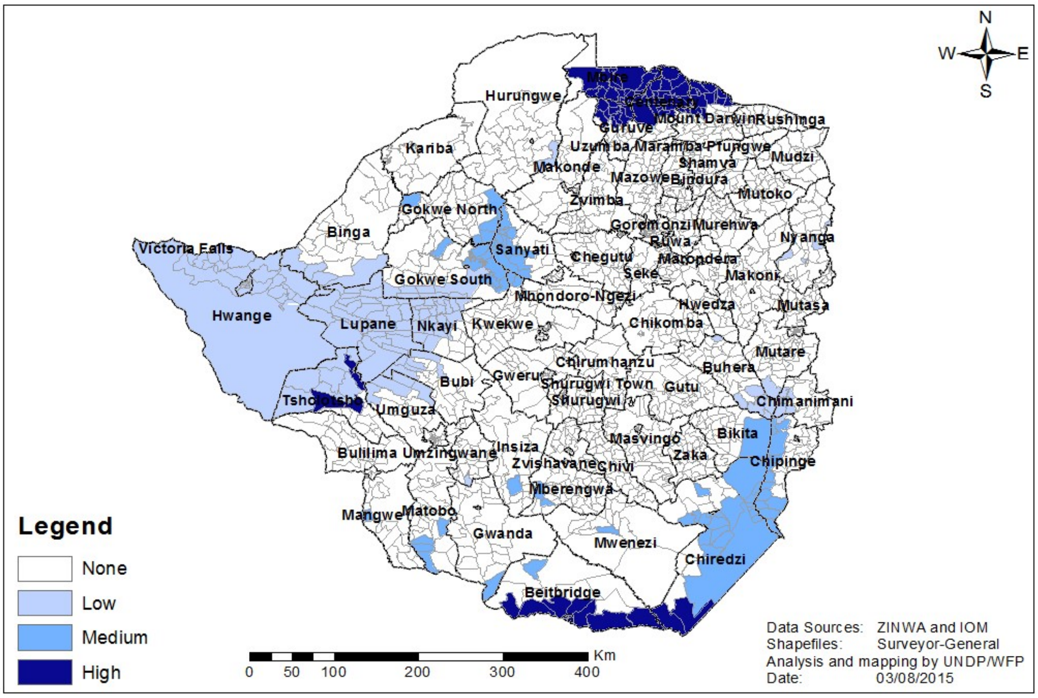


Figure 17: Flood map of Zimbabwe.

*Source: ZRBF*

Table 4 documents the most severe tropical cyclones since the 1970s up to 2012 and the amount of rainfall which fell in 24 hours – note that this is usually only a part of the total rainfall as most cyclones result in rainfall occurring over 1-5 days. Observed changes in the frequency of different categories of cyclones (numbers of category 4 & 5 increasing from 36 [1980-1993] to 56 [1994-2007][94] and category 5 increasing[95]) and future climate change scenarios both suggest that whilst there may not be changes in the total frequency of cyclones in the southwest Indian Ocean, the proportion of cyclones in the high intensity categories (4 & 5) is expected to increase relative to the proportion of category 1-3 cyclones[96].

Table 4: Cyclone frequency and intensity in Zimbabwe.

| Month/year | Name | 24-hour precipitation (mm) |
|---|---|---|
| January 1976 | Danae | 78.5 |
| February 1977 | Emilie | 175 |
| January 1986 | Berobia | 179 |
| February 1997 | Lissette | 62.5 |
| February 2000 | Eline | 153 |
| February 2003 | Japhet | 204 |

*Source: IUCN cited in Davis and Hirji (2012)*

## 1.7 Vulnerability to climate change: key risks and impacts to agricultural livelihoods in southern Zimbabwe

The key climate change risks are from increasing temperatures, more variable and extreme precipitation, increasing aridity, and the intensification of droughts and floods. All of these changes in climate place significant threats on traditional crop-livestock strategies practiced by smallholders in southern Zimbabwe and the country's agro-based economy. Increasing temperatures, coupled with reducing rainfall and increasing evapotranspiration, lead to increased aridity, the expansion of marginal lands and decreasing ability of soils to retain water. Punctuated by increasingly intense extremes, reducing and variable precipitation is projected to cause changes to the growing

[94] Mavume A. et al. (2009) Climatology and Landfall of Tropical Cyclones in the South West Indian Ocean. Western Indian Ocean J. Mar. Sci. Climatology & Vol. 8, No. 1, pp. 15–36

[95] Mawren, D., and C. J. C. Reason (2017), Variability of upper-ocean characteristics and tropical cyclones in the South West Indian Ocean, J. Geophys. Res. Oceans, 122,

[96] Knutson, T. R., McBride, J. L., Chan, J., Emanuel, K., Holland, G., Landsea, C., Sugi, M. (2010). Tropical cyclones and climate change. *Nature Geoscience*, *3*(3), 157–163. https://doi.org/10.1038/ngeo779

season and crop patterns, posing significant implications to yields and national revenues. Increased temperatures also pose risks such as increasing the likelihood of veld fires and changes to the distribution and seasonality of diseases, as well as rangeland productivity, which have particular implications on livestock production systems. These climate threats significantly reduce the production capability of crop and livestock systems, threaten agricultural based livelihoods and place further strain on already scarce water resources. The threats these changes pose to communities' food and income security and their ability to adapt to climate change are discussed in more detail below.

### *1.7.1 Impacts of climate change on agricultural livelihoods*

#### *1.7.1.1 Cropping systems*

Rainfall is one of the most critical factors determining the production of crops and livestock. The impacts of climate change on agricultural livelihoods are illustrated by the impacts of declining rainfall on the production of maize, the staple food crop in southern Zimbabwe. Maize is extremely susceptible to changes in water because of its comparably high yield sensitivity to water stress[97]. Analysis by Nyabako and Manzungu (2012) shows that **smallholder farmers who live in AERs III, IV and V will be unable to grow rain-fed maize under climate change, even using current drought tolerant varieties**[98]. Increasing temperatures and rainfall variability, leading to increasing aridity of lands and reduced water availability, are causing maize to become increasingly unable to grow under current ecological conditions. This has **direct consequences for the food and income security of about 3.9 million people (or 700,000 households) across the southern provinces**[99]. Nyabako and Manzungu (2012) further highlight that the area suitable for growing rainfed medium maturing maize varieties will decline to below 20% in AERs IV and V and, overall, predict that only 2% of Zimbabwe's land area, mainly in AER I, will be suitable for growing high yielding late maturing maize varieties[100]. A World Bank (draft) analysis of rain fed crop yield relative to irrigated yield and spatial distribution of rain-fed crops for the baseline period of 1950-1999 and under climate change (for the period 2041-2050), has modelled the major grain and cash crops: maize, sorghum, millet, groundnuts, cotton and tobacco, reinforces their findings[101]. As shown in Figure 18 and Figure 19, 'mean change in rain-fed yield fraction relative to irrigated show a negative change for all crops, with the largest decreases in southern parts of the country. The decrease is particularly extreme for maize'[102]. It is also clear from the figures that under current climate conditions, southern areas of the country have the greatest potential to increase yields (relatively) through the application of irrigation for all crops (particularly maize). In the future, in the absence of irrigation, crops other than maize should be grown to reduce the negative impacts of climate change on crop yields.

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[97] Manzungu, E. et al. 2016. (Draft) Potential impacts of Climate Change and Adaptation Options in Zimbabwe's Agricultural Sector. World Bank.
[98] Ibid.
[99] Ibid.
[100] Ibid.
[101] The analysis of the climate projections for the period 2041-2050 used data from the World Bank Enhancing the Climate Resilience of Africa's Infrastructure(ECRAI) Africa-wide study, complemented and calibrated using national data sources (1950s to 2010). Long term projected climate change scenarios were based on downscaling of the global and Africa-wide data drawing on the modeling completed as part of the ECRAI study and other studies. The data was calibrated to Zimbabwe circumstances with reference to the National Climate Change Response Strategy.
[102] Ibid. Under the majority of the 121 climate scenarios.

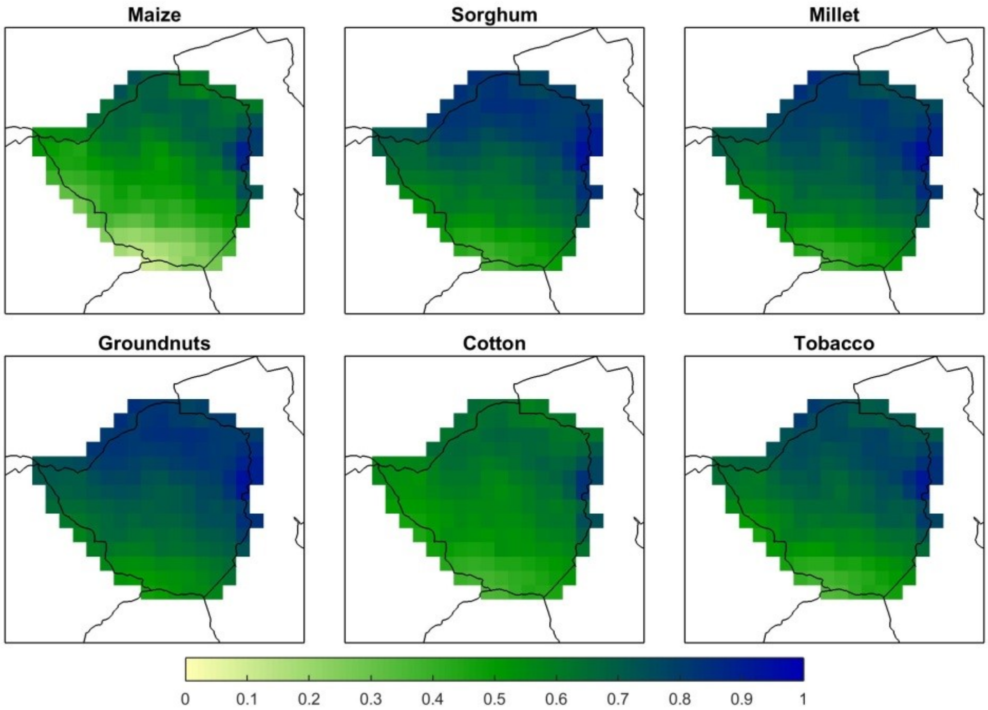


Figure 18: Historical rain-fed yield fraction relative to irrigated – 1950-1999.

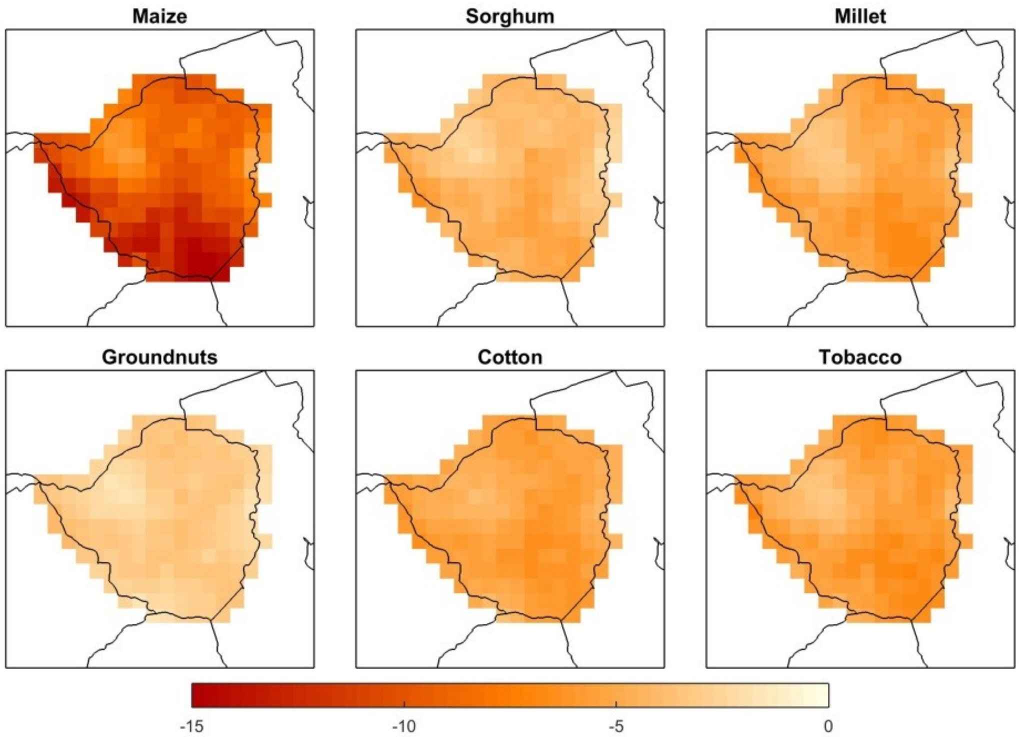


Figure 19: Expected reduction in 2014-2050 of rain-fed yield in % (relative to irrigated) from 1950-1999 baseline.

Severe droughts, mid-season dry spells and floods, are causing significant shocks to agricultural production, which threaten farmers' livelihoods and limit economic growth in the absence of adaptive measures in the agriculture sector. Droughts in particular tend to have a direct impact on economic performance[103]. Annual GDP significantly declined in the drought years of 1983, 1987, 1992 and 1995[104]. GDP dropped by 8% in real terms and agriculture's contribution to GDP fell by 3% after the 1991/1992 drought[105]. The most recent El Niño-induced drought, recorded to be the strongest in 35 years, impacted negatively on rain fed agriculture during the 2015/16 season, and the agricultural sector as a whole is estimated to have shed 3.7% over 2016 [106,107]. From April 2016-March 2017, GoZ provided food relief to nearly two million vulnerable people affected by drought at an estimated cost of US$215 million[108,109]. A few years later The Zimbabwe Flash Appeal from 2019 estimated that 5,3 million people in drought affected districts were in urgent need of humanitarian assistance in the 2018/2019 lean season. This reduces potential GoZ investment in adaptation measures, undermining the country's ability to respond to increasing climate impacts. On a reoccurring basis, droughts systematically destroy communities' assets and capacity to build climate risk management into their livelihoods. Droughts also have impacts on water availability for domestic and industrial use and power generation, affecting cities and non-agriculture sectors[110].

The increasing frequency of **mid-season dry spells** results in crops being exposed to severe heat stress during the harvesting season, which can often lead to crop failure in rain-fed farming systems. Analysis by Kuri et al. (2014) shows that **mid-season dry spells are a major limiting factor on rain-fed agriculture yield potential[111]**. They analyse the relationship between the number of 'dry dekads' – a ten-day period with a Vegetation Condition Index value below 35%[112] – in a particular wet season to the corresponding maize yield that was harvested at the end of that season, using linear regression (Figure 20)[113]. The results indicate that there is a consistently significant negative linear relationship between the number of dry dekads and average maize yield for the four consecutive wet seasons considered in the study (from 2009 to 2013)[114]. In other words, the higher the number of dry dekads experienced during the crop growing season, the higher the drought related stress that the crop experiences, resulting in poor crop yield. The models were developed over the wet season consisting of 18 dekads (the range found in the four wet seasons), meaning a season can only have maximum of 18 dekads of which, if they are all dry, yields are zero. Figure 20 suggests that farmers practicing rain-fed agriculture in southern Zimbabwe are the most prone to mid-season dry spells and therefore as a result expected to experience significant deteriorations in crop yields.

[103] Glantz, M. H., Betsille, M., & Crandall, K. 2007.. Food Security in Southern Africa: Assessing the Use and Value of ENSO Information, Environmental and Societal Impacts Group (ESIG), National Center for Atmospheric Research (NCAR), Boulder, CO 80307 USA.
[104] Anseew, A. Kapuya, T., and Saruchera, D. 2012. *Zimbabwe's agricultural reconstruction: Present state, ongoing projects and prospects for investment.* Development Planning Division Working Paper Series No. 32. Development Bank of Southern Africa, Johannesburg.
[105] Chimhou, A., Manjenga, M., & Feresu, S. 2010. *Moving Forward in Zimbabwe: Reducing Poverty and promoting Growth*. Second Edition. Institute of Environmental Studies, University of Zimbabwe, Zimbabwe.
[106] 2016 Economic Review, UNDP
[107] ZimVAC. 2016. Zimbabwe Vulnerability Assessment Committee 2016 Rural Livelihoods Assessment. SIRDC. ZimVAC, Harare.
[108] United Nations. 2017. ZUNDAF: Development Partnership Delivers Strong Results in Zim. Available on: http://www.zw.one.un.org/newsroom/news/development-partnership-delivers-strong-results-zim (Accessed 17 April 2017)
[109] The total amount applied for in the 2016-2017 Drought Disaster Domestic and International Appeal for Assistance was $1.5 billion. *Source*: ZimVAC. 2016. Zimbabwe Vulnerability Assessment Committee 2016 Rural Livelihoods Assessment. SIRDC. ZimVAC, Harare.
[110] UNDP and ZRBF. 2016. Mapping of Selected Hazards Affecting Rural Livelihoods in Zimbabwe: A District and Ward Analysis. ZRBF, Harare.
[111] Kuri, F. et al. 2014. Predicting maize yield in Zimbabwe using dry dekads derived from remotely sensed Vegetation Condition Index. International Journal of Applied Earth Observation and Geoinformation. 33, pp.39-46.
[112] Liu, W.T., Kogan, F.N. 1996. Monitoring regional drought using the Vegetation Condition Index. Int. J. Remote Sens. 17 (14), 2761–2782.
[113] Kuri, F. et al. 2014. Predicting maize yield in Zimbabwe using dry dekads derived from remotely sensed Vegetation Condition Index. International Journal of Applied Earth Observation and Geoinformation. 33, pp.39-46.
[114] The Shapiro–Wilk test for normality showed that the data (average yield for all wards with the same number of dry dekads) is not normally distributed and the Spearman's Rho correlation test indicated that there is high correlation between the average maize yield and number of dry dekads. *Source:* Kuri, F. et al. 2014. Predicting maize yield in Zimbabwe using dry dekads derived from remotely sensed Vegetation Condition Index. International Journal of Applied Earth Observation and Geoinformation. 33, pp.39-46.

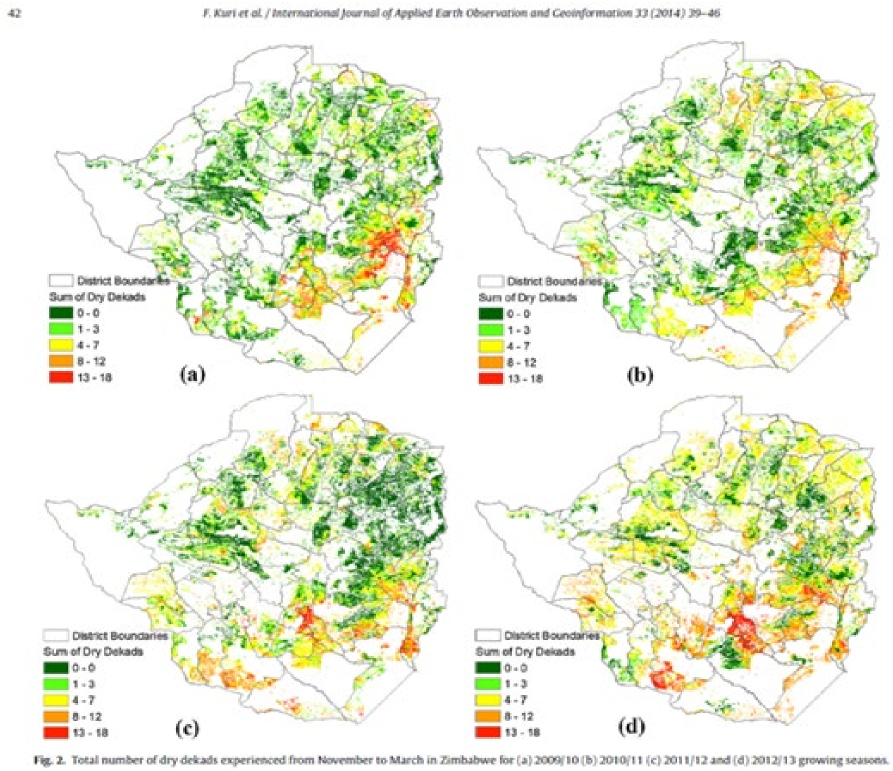


Figure 20: Total number of Dry Dekads for November to March in Zimbabwe in (a) 2009/10, (b) 2010/11, (c) 2011/12, (d) 2012/13 growing seasons.

*Source: Kuri, F. et al. 2014.*

**Extreme flooding** events can also lead to harvests being washed away and increased damage to infrastructure, such as roads, bridges, irrigation, and agricultural processing and storage facilities. Most rural farming areas are inaccessible due to a lack of or dilapidated infrastructure, such as small bridges and remote tracks, in part as a result of damage from floods and heavy rains. After the recent flooding caused by cyclone Idai, a significant number of irrigation schemes and road infrastructures were washed away or damaged and in total damages to irrigation schemes worth US$ 4,890,000 were registered [115].

This makes crucial services such as government extension services, markets and related information, agro-inputs and access to finance difficult for communities to reach, increasing the level of risk communities' are exposed to. Flooding also increases erosion in rivers and siltation of dams and weirs, affecting agriculture productivity (see Annexes 5 and 6 for siltation rates and sediment loads in Zimbabwe's rivers and dams). Given the observed trends and projected increases in high intensity rainfall, as well as the modelled future scenarios of increases in maximum water discharges shown above, these flooding impacts are expected to be more prevalent/severe in the future.

Rising temperatures in combination with more variable and decreasing rainfall are also likely to result in **increasing aridity and the expansion of marginal lands. Furthermore, the changing seasonality of rainfall (e.g. later onset) and temperatures will affect cropping patterns and timing, as well as threaten the ability of crop-livestock production systems to produce meaningful yields.** As shown in Figure 21, the distribution of AERs has changed since 1960 and is projected to favour more aridity under climate change. Based on measurements of average climatic conditions of 1972-2006 it is estimated that currently AERs II and III, the most suited areas for rain-fed crop and livestock production have decreased significantly, while **already poorly suited regions to rain-fed farming systems (AERs IV and V) have expanded by close to a third**[116,117]. This contributes to rain-fed farming systems in AERs IV and V becoming increasingly unsustainable, and even mixed crop-livestock systems in these areas are expected to become more vulnerable, as natural processes in semi-arid

[115] Rapid Impacts and Needs Assessment (2019) GoZ, GFDRR, World Bank
[116] Mugandani R, Wuta M, Makarau A, Chipindu B. 2012. Re-classification of agro-ecological regions of Zimbabwe in conformity with climate variability and change. African Crop Science Journal 20:361 – 369.
[117] Nyabako, T., and E. Manzungu, 2012. An assessment of the adaptability to climate change of commercially available maize varieties in Zimbabwe. Environment Natural Resources, 2: 32-46.

areas that sustain soil moisture for rain-fed cropping and fodder production for livestock are negatively affected[118,119,120].

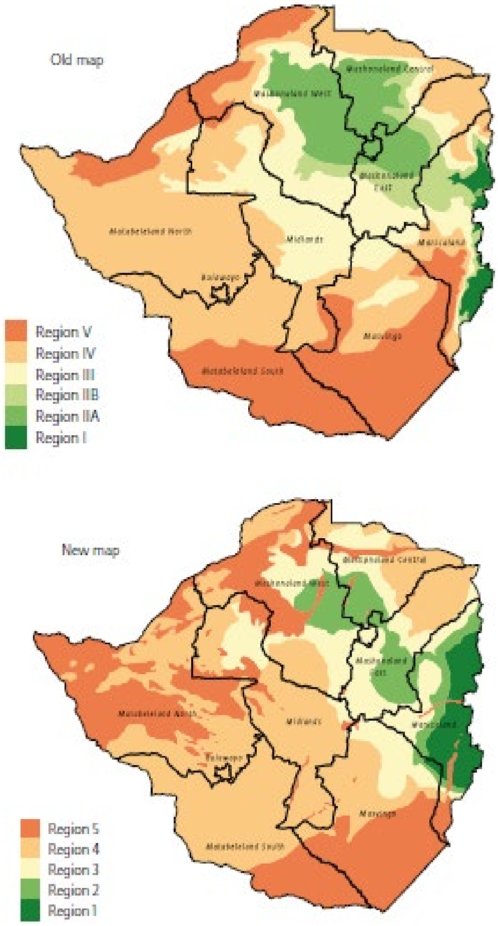


Figure 21: Zimbabwe's spatial distribution of AERs as mapped in 1960 (top); and based on climate trends (bottom).

*Source: Mugandani et al. (2012)*

Changes in temperature and precipitation are also predicted to impact the **Length of the Growing Period** (LGP), a key determinant of potential crop production. The World Bank 2016 (draft) study shows that under climate change, the mean percentage change in LGP is highest in the south and southwest of the country, and lowest in the north and northeast (Figure 22), indicating a shrinking LGP in southern parts of Zimbabwe[121]. Communities in southern areas may therefore experience even further constricted production cycles and changes to seasonality, triggering and demanding adaptive responses in livelihood strategies regarding crop choices and harvesting scheduling.

[118] Kahinda et al. 2007. Rainwater harvesting to enhance water productivity of rain-fed agriculture in semi-arid Zimbabwe. Physics and Chemistry of the Earth, 32 (2007), pp. 1068-1073.
[119] Wani, et al. 2009. Rain-fed Agriculture: Unlocking the Potential. Wallingford, UK. pp: 124-132.
[120] Tadross. M, P. et al. 2008. Growing-season rainfall and scenarios of future change in southeast Africa: implications for cultivating maize. Climate Research: Integrating analysis of regional climate change and response options. Vol. 40, pp.147-161.
[121] According to the spatial distribution of the mean percentage change across 121 climate scenarios (taken from the World Bank's (2015) *Enhancing the Climate Resilience of Africa's Infrastructure (ECRAI) Africa-wide Study* and complemented and calibrated using national data sources (1950s to 2010). *Source:* Manzungu, E. et al. 2016. (Draft) Potential impacts of Climate Change and Adaptation Options in Zimbabwe's Agricultural Sector. World Bank.

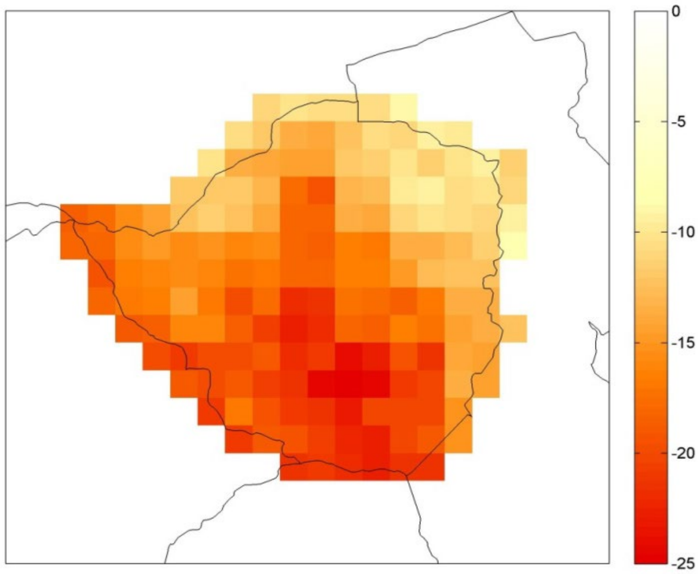


Figure 22: Mean change in Length of the Growing Period under climate change 2041-2050 (%) from Baseline 1950-1999.

*Source: World Bank (draft)*

**Yield reductions in crops, particularly cash crops, will significantly reduce household and national level revenues, incomes and employment**[122]. Mano and Nhemachena (2007) predict that a 2.5$^{o}$ C increase in temperature can cause a significant decrease of net farm revenue by US$400 million across the country, and a decrease in precipitation of between 7 and 14% would result in a decrease in farm revenue of US$300 million[123]. The financial losses incurred from cash crop yield reductions will substantially undermine rural livelihoods, as there will be a significant loss of farm jobs, wages, and net farm incomes, which finance various social needs (e.g. health, education etc.)[124]. While this will profoundly affect rural livelihoods, both directly in terms of even more limited employment opportunities and indirect effects of a worsening rural economy (for those currently outside of employment opportunities), it will have drastic implications for the national economy, given the heavy reliance on agro-based industries.

### *1.7.1.2 Livestock systems*

Climate change impacts on **livestock production systems** pose a major threat to rural household food and income security, as livestock production (usually cattle or goat) for many farming livelihoods plays an important role as a means of diversification of income for food, school fees and healthcare, among other basic needs, and a major source of insurance against seasonal crop failures, as livestock can be sold to purchase food during drought years[125,126]. Livestock production systems are common in the southern provinces: In 2016 Masvingo and Matabeleland South provinces had approximately 1 002 446 and 565 073 million cattle respectively. The two provinces have about 28% of the national cattle herd. (see Annex 3 for an overview of livelihood strategies)[127]. Livestock is grazed on rangelands. Increasing temperatures and variable precipitation are causing Zimbabwe's distinctive 7-8 month dry season to intensify and lengthen (see Figure 7) and droughts to increase in both occurrence and frequency, the impacts of which pose significant and particular threats to livestock production systems. Increased soil erosion and reduced natural soil processes are projected to have severe effects on natural forage production. Primary biomass production (or Net Primary Productivity) is predicted to fall over the next 35

[122] Manzungu, E. et al. 2016. (Draft) Potential impacts of Climate Change and Adaptation Options in Zimbabwe's Agricultural Sector. World Bank.
[123] Mano and Nhemachena. 2007. *Cited in:* Manzungu, E. et al. 2016. (Draft) Potential impacts of Climate Change and Adaptation Options in Zimbabwe's Agricultural Sector. World Bank.
[124] Manzungu, E. et al. 2016. (Draft) Potential impacts of Climate Change and Adaptation Options in Zimbabwe's Agricultural Sector. World Bank.
[125] Ibid.
[126] IFAD. 2016. Republic of Zimbabwe: Smallholder Irrigation Revitalisation Programme: Detailed Design Report. East and Southern Africa Division, Programme Management Department, IFAD.
[127] ZimVAC. 2016. Zimbabwe Vulnerability Assessment Committee 2016 Rural Livelihoods Assessment. SIRDC. ZimVAC, Harare.

years from 8 tonnes to 5 tonnes/ha, significantly decreasing the potential use value of rangelands[128,129]. **Lack of feed** during dry seasons and droughts **is the number one cause of livestock death** (Figure 23)[130]. The 2015/16 El Niño-induced drought resulted in widespread crop failure and deaths of over 25,000 cattle, mainly in southern parts of the country, with 15,000 cattle lost in Matabeleland South, Masvingo and Manicaland[131]. Also, recent studies of farming systems have demonstrated increasing conflicts among livestock and cropping systems and wildlife, as livestock are being pushed out of farming systems due to a lack of suitable grazing space[132]. Reduced forage has resulted in increased wildlife movement into communal areas and irrigation schemes in search of pastures. Greater incidences of veldt fires related to increased temperatures are another predicted impact, also threatening the carrying capacity of rangelands. Additionally, **reduced livestock watering sources**, especially in communal areas, presents a serious challenge. In the drier areas (AERs IV and V), the water table decreases in the dry season to the point where in some cases it is too expensive for farmers to pump water, meaning farmers are unable to provide livestock with fresh water to keep them alive.

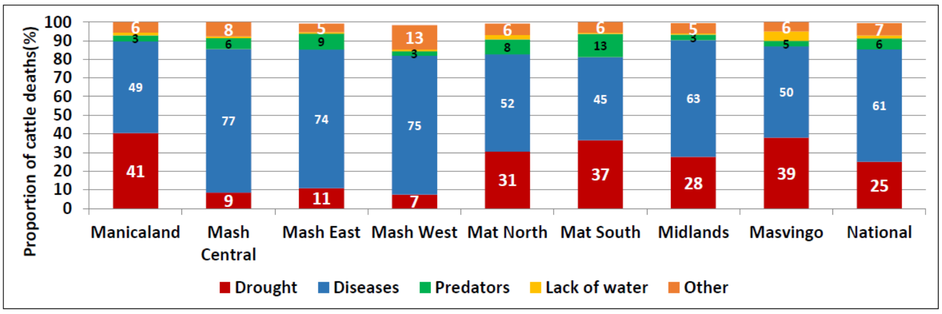


Figure 23: Causes of cattle loss in Zimbabwe during the 2015/2016 agricultural season.

*Source: ZimVAC, 2016*

**Increasing temperatures also affect the distribution of diseases, which are a major cause of cattle loss across the country (**Figure 23**)** . According to the 2013 ZimVAC report, districts in southern Zimbabwe (areas close to Save Valley and Malilangwe, Gonarezhou; Umzingwane and Tuli) were the most affected in the country, and areas close to protected areas within these districts experienced the greatest incidence of animal diseases, due to the interaction between livestock and wildlife, as they seek out water and forage matter. Diseases such as heart water, blackleg, Newcastle, foot and mouth and anthrax are common. Climate change impacts are predicted to increase the spread, diversification, distribution, range, prevalence, incidence and seasonality of diseases. Climate change may also affect the spatial extent of other livestock disease outbreaks. For example, trypanosomiasis cases can rise through modification of habitats suitable for tsetse-flies, which are expected to change under climate change.

### *1.7.1.3 Land degradation and siltation*

Climatic variations and extreme climate events, such as torrential rains and flooding, are some of the major factors contributing to, or even triggering, **land degradation**. Rising temperatures have been and will continue to increase evapotranspiration, contributing to poor organic matter production and low soil aggregation stability, resulting in higher potential for wind and water erosion and reduced ability to maintain moisture in the soil. This is worsened by climate-induced torrential rains and flash floods that wash off soil in the catchment and cause concomitant damage to infrastructure. In the absence of irrigation technologies for harnessing water and limited use of effective water and moisture conservation practices in rain-fed farming systems, climate-induced water stress may force more smallholders into stream-bank and in-stream cultivation, as well as deforestation in search of land with access to water resources. This in turn increases the likelihood of the degradation of land from erosion, which

[128] Net Primary Productivity provides an estimate of how much biomass and therefore forage is available in a rangeland.
[129] Vulnerability studies on the livestock sector, carried out during formulation of Zimbabwe's Second Communication to the UNFCCC: Mavedzenge, et al. 2006. Changes in the livestock sector in Zimbabwe following land reform: the case of Masvingo province. www.lalr.org.za. Ndebele, et al. 2007. Cattle breeding management practices in the Gwayi smallholder farming area of South-western Zimbabwe. Livestock Research for Rural Development 19 (12). Available on: http://www.lrrd.org/lrrd19/12/ndeb19183.htm (Accessed 18 July 2016)
[130] ZimVAC. 2013. Zimbabwe Vulnerability Assessment Committee 2013 Rural Livelihoods Assessment. SIRDC. ZimVAC, Harae.
[131] ZimVAC. 2016. Zimbabwe Vulnerability Assessment Committee 2016 Rural Livelihoods Assessment. SIRDC. ZimVAC, Harare.
[132] Mavedzenge, et al. 2006. Changes in the livestock sector in Zimbabwe following land reform: the case of Masvingo province. www.lalr.org.za. Ndebele, et al. 2007. Cattle breeding management practices in the Gwayi smallholder farming area of South-western Zimbabwe. Livestock Research for Rural Development 19 (12). Available on: http://www.lrrd.org/lrrd19/12/ndeb19183.htm (Accessed 18 July 2016)

increases siltation in river-beds and man-made water delivery channels, reducing the lifespan of dams and irrigation infrastructure. Overall, this results in a potential **reduction in the availability of water for crop production for both irrigated and dryland farming systems** and compromises yields and ecosystems on a catchment level. A survey by Interconsult on siltation rates within small to medium sized dams in communal lands revealed that **sediment yields were about 400 to 700 tonnes/km2/yr[133].** This would result in a **5 to 10% loss in live storage** over a 72 to 115 year period. See Annex 5 for a record of annual average sediment load in Zimbabwe's rivers and stations and Annex 6 for siltation rates in dams.

#### *1.7.1.4 Water resources and irrigation*

**Water resources** are subjected to high hydro-climatic variability over space and time, and are a key constraint to Zimbabwe's continued economic development[134]. Severe impact on water resources has **mostly been felt in rural households'** water supply. **Groundwater** provides water to more than 70% of the population[135]. It is **the main water source for domestic use and crop and livestock watering in rural areas and a major source of water for small scale irrigation[136]**. Zimbabwe has **limited groundwater resources** due to weathered and fractured crystalline rock formation of the basement complex that underlies more than 60% of the country[137]. It is estimated to be in the region of 6 $km^3$/per year. Total renewable **surface water** resources are estimated to be 20 $km^3$/year, while internally produced water resources account for 12.26 $km^3$/yr[138]. Potential yield is predicted to be 8.5 $km^3$/yr (of which 56% is already committed), with the balance of 3.7 $km^3$/yr available for irrigation and other uses. Irrigation uses 82% of the developed water resources, mining 3%, urban and industry 1.4%, and conservation, mining and hydropower generation 1%[139]. Based on available internal renewable water resources, the irrigation potential of the country is estimated at around 365,000 ha, considerably less than irrigable land, which is estimated at 600,000 ha[140,141]. The availability of water resources and inefficiencies in supply and use are therefore limiting factors to irrigation potential. The estimation of the irrigation potential is based on a 10% risk factor and a water supply of 10ML per hectare. In smallholder irrigation schemes, the allocation can be as high as 15 Ml/ha because of lower irrigation efficiencies regarding operation and maintenance (O&M) in schemes. See Annex 2 for a more detailed overview of Zimbabwe's water resources.

Like many other sub-Saharan countries, Zimbabwe suffers from both physical and economic water scarcity. Physical water scarcity refers to the limited availability of water resources, while economic refers to the lack of financial and institutional capacity to develop water resources[142]. Under climate change, less water will be available either as *green water* – the fraction of water that infiltrates into the soil and is available to plants, which is the basis of rain-fed crop production and rangeland-based livestock production – or as *blue water* – referring to the fraction of rainfall that reaches rivers directly as runoff or indirectly through deep drainage to groundwater that eventually flows to rivers as base flow, as well as water stored in dams and lakes, which is critical for irrigation[143]. Groundwater will be **most affected in the southern catchments of Mzingwane and Runde** and least affected in the north. The magnitude of the percentage negative change in irrigation potential will be the same for all basins irrespective of the crops grown, and this will range from 1% for Mzingwane and 27 and 29% for Gwayi and Sanyati respectively[144]. This means that the country's irrigation potential could be reduced by up to a third, to 244,550ha, if measures to improve water use efficiency are not taken.

Beginning in the mid-1900s, successive administrations have invested in smallholder irrigation schemes on communal lands to increase water availability for agricultural livelihoods, managed by community-run Irrigation Management Committees (IMCs) (see Annex 7 for an overview of smallholder irrigation in Zimbabwe). Irrigation can have an enhancing and stabilizing effect on crop yields, and under the right conditions, it can enhance maize

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[133] Interconsult. 1985. Siltation and Soil Erosion Survey in Zimbabwe. Available on: http://hydrologie.org/redbooks/a159/iahs_159_0069.pdf (Accessed 18 July 2016)
[134] Davis, R. and R. Hirji. 2014. Climate Change and Water resource Planning, Development and Management in Zimbabwe. An Issues Paper. World Bank.
[135] MacDonald, A.M., Davies, J. and Calow, R.C. 2008. African hydrogeology and rural water supply. In: Segun. A. MacDonald, A. (Eds.) *Applied ground water studies in Africa*. London. CRC Press. 127-148.
[136] Ibid.
[137] Ibid.
[138] FAO. 2011. FAOSTAT. Available on: http://www.fao.org/countryprofiles/index/en/?iso3=ZWE (Accessed 18 July 2016)
[139] ZINWA. 2009. Assessment of surface water resources of Zimbabwe and guidelines for planning. Harare, Zimbabwe.
[140] EuroconsultDelft/Hydraulics Laboratory/Royal Tropical Institute. 1987. Study on options and investment in irrigation development: Country report, Zimbabwe.
[141] Food and Agriculture Organisation (FAO) 2011. Aquastat, Zimbabwe.
[142] Van Koppen, B. 2003. Water Reforms in Sub-Saharan Africa: What is the difference? *Physics and Chemistry of the Earth,* **28**: 1047-1053.
[143] Ringersma, J., Batjes, N. and Dent, D. (2003). *Green Water: Definitions and Data for Assessment. Report 2003/2.* ISRIC -World Soil Information, Wageningen.
[144] Manzungu, E. et al. 2016. (Draft) Potential impacts of Climate Change and Adaptation Options in Zimbabwe's Agricultural Sector. World Bank.

and other yields by up to 440% (Table 5)[145]. Crops grown under irrigation account for almost half of the total value of marketed crops in the country[146], yet only 3% of arable land is irrigated[147]. Irrigation allows for double cropping, as farmers are able to crop in the dry winter season when dryland production is virtually impossible, as well as in the traditional summer rainy season[148]. Irrigation also allows farmers to practice more intensive crop production and diversification into higher-value crops for local and export markets, increasing their opportunity to generate revenue and the ability to manage risks and uncertainties[149]. Irrigation provides income and employment benefits for communities directly on schemes and the wider rural population. Incomes for irrigation farmers are usually higher than dryland farmers, and, in some cases, are substantially higher than the annual minimum wage of an unskilled urban worker in the Zimbabwean industry sector. Schemes themselves act as a direct source of employment, as they hire labour to assist in land preparation, weeding and harvesting, where payment is in cash and/or in kind. Cash crops grown under irrigation can also create employment, through backward and forward linkages (involving rural input suppliers and rural agro-dealers), as well as indirectly through multiplier effects.

Table 5: Impact of irrigation on crops commonly irrigated in Zimbabwe. *Source*: ECA (2013)

| Crop | Yield under rain fed (t/ha) | Yield under irrigation (t/ha) | Impact of irrigation on yield (%) |
|---|---|---|---|
| Maize | 1.6 | 5.8 | 263 |
| Groundnuts | 0.5 | 2.7 | 440 |
| Soya beans | 1.4 | 2.4 | 71 |
| Cotton | 0.8 | 2.4 | 200 |
| Tobacco | 2.0 | 2.9 | 45 |
| Sugarcane | - | 110 | - |
| Wheat | - | 5.2 | - |
| Barley | - | 5.0 | - |
| Beans | 1.0 | 1.3 | 30 |
| Coffee | 1.2 | 1.7 | 42 |
| Tea | 2.8 | 3.2 | 14 |
| Tomatoes | - | 20 | - |

Despite irrigation being a priority government investment[150], only a few communities have access to small-scale, functional irrigation infrastructure. Available data shows that only 19 percent of all rural wards in the country have irrigation schemes and non-functioning irrigation schemes are widespread[151]. According to the 2014 ZimVAC report, only 44% of irrigation schemes under the control of smallholders (through IMCs) are functional (Figure 24)[152]. These findings were corroborated by visits to 13 irrigation schemes during the preparation of this proposal, where 50% of the schemes were found to be either not operational or operating sub optimally, and reinforced by visits to a further 16 irrigation schemes in the Climate Resilient Irrigation Sub-assessment.

Potential benefits from years of investment in smallholder rural irrigation development intended to boost food production have not been realised or **have been lost due to climate induced dry spells**, high temperatures, as well as flooding and torrential rains that cause high surface runoff, **deposit silt in rivers and dams and destroy infrastructure,** thereby **reducing water storage capacity**. Several studies on smallholder irrigation schemes and rain fed agriculture reveal that maize **yields have dropped from an average 5t/ha to as low as 0.8t/ha** and 0.1t/ha respectively as a result of climate induced water supply deficit and temperature stress[153,154,155]. Analysis by Makadho (1996) investigating the effect of two climate change scenarios (CCM x 2 $CO_2$ and GFDL x 2 $CO_2$)

[145] Economic Consulting Associated/Dorsch International Consultants/Brian Colquohoun, Hugh O'Donnel and Partners, 2013. Zimbabwe: Water sector investment Analysis: Full Technical Report, Harare, Zimbabwe.
[146] FAO. 1995. Irrigation in African in Figures. FAO, Rome, Italy.
[147] World Bank. 2015. Supporting Zimbabwe's climate resilience agenda: Background notes in support of the National Climate Policy, including Note A: Agriculture; Note B: Water; Note C: Climate Resilient Infrastructures; Note D: Forests; Note E: Technical Appendix on Climate Change Scenarios.
[148] IFAD. 2016. Republic of Zimbabwe: Smallholder Irrigation Revitalisation Programme: Detailed Design Report. East and Southern Africa Division, Programme Management Department, IFAD.
[149] Ibid.
[150] See Chapter 2: NCCRS, NCP, Comprehensive Agricultural Policy Framework etc.
[151] ZimVAC. 2016. Zimbabwe Vulnerability Assessment Committee 2016 Rural Livelihoods Assessment. SIRDC. ZimVAC, Harare.
[152] ZimVAC. 2014. Zimbabwe Vulnerability Assessment Committee 2014 Rural Livelihoods Assessment. SIRDC. ZimVAC, Harare.
[153] Chancellor, F. 2004. "Sustainable Irrigation and the Gender Question in Southern Africa". University of Zimbabwe Publications, Harare.
[154] Unganai, S.L. and A, Murwira. 2010. Challenges and opportunities for climate change adaptation among smallholder farmers in southeast Zimbabwe. 2nd International Conference: Climate, Sustainability and Development in Semi-arid Regions [August 16-20, 2010]. Fortaleza-Ceara, Brazil.
[155] Manzungu, E. and Zaag van der, P. 1996. Continuity is smallholder irrigation. *In;* Manzungu, E. and Zaag van der, P. (eds.) The practice of smallholder irrigation: Case studies from Zimbabwe, Harare: University of Zimbabwe Publications, 1-28.

on maize in four locations (Karoi, Masvingo, Beit Bridge and Gweru) shows that irrigated maize yields are projected to decrease by between 11 and 17% compared to normal climate (the baseline). Also, many smallholder irrigation schemes are located in poor rainfall catchments that are predicted to experience even less rainfall as a result of climate change. Therefore, it is likely that many schemes will become increasingly inefficient over time if they do not have adequate water storage and capture facilities that factor in climate-induced water shortage and highly variable rainfall[156]. Additionally, the increase in frequency and intensity of extreme events, such as droughts and floods, pose increasingly significant risks to existing irrigation scheme infrastructure and management systems. Intense floods are likely to damage infrastructure that does not have the ability to withstand extreme events and water fluctuations. Such impacts compromise traditional irrigation design and complicate water resource management regarding pumping operation and irrigation scheduling. Increases in storms and flash flooding, which contribute to siltation, will also reduce the functionality and efficiency of irrigation infrastructure over time.

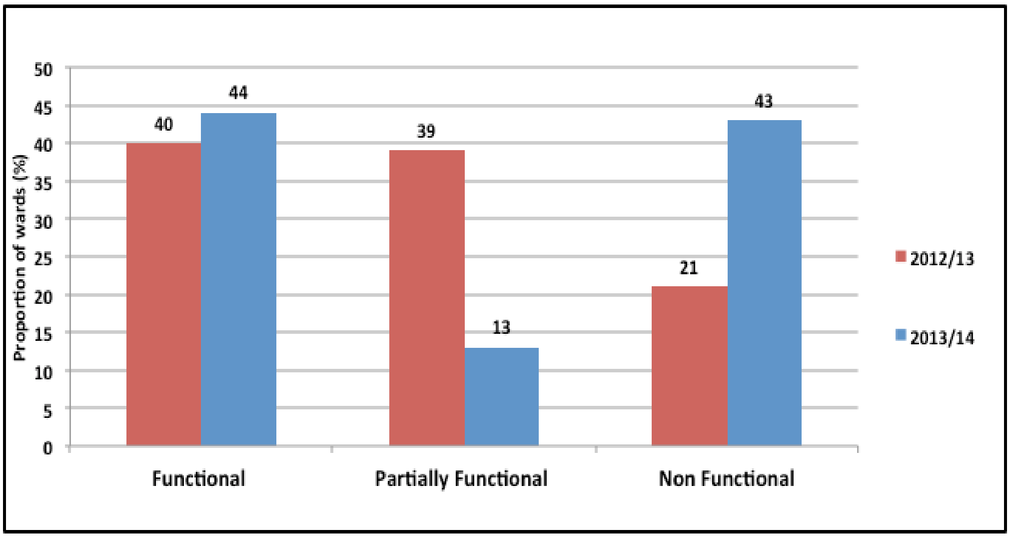



Figure 24: Status of irrigation schemes in selected wards.

*Source: ZIMVAC, 2014*

### *1.7.2 Disproportionate impacts on women and vulnerable groups of climate change affected agricultural livelihoods*

The impacts of climate change, which often manifest in multi-hazards, are multi-faceted. For example, a flood can cause seemingly obvious impacts, such as loss of crops, destruction of water storage facilities and damage to roads, which reduce food and income security and access to vital services. Flood damage can also cause more indirect and subtle impacts, such as preventing people living in rural areas from accessing medical services, particularly daily medication such as HIV antiretroviral drug. They are also multi-faceted in the different ways in which they affect individuals, households, communities and systems, depending on their inter-dependent socio-economic circumstances, capacities, and access to rights and resources[157].

Women are disproportionately affected by climate change. Zimbabwe's demographic data published by the National Statistical Agency shows that more women than men are poor and live in rural areas where livelihoods are intimately linked with natural resources and are extremely vulnerable to climate change impacts[158,159]. Gender differences in property rights, access to information, finance, markets, and cultural, social and economic roles equip women with the least capacity to cope or prepare for climate risks, resulting in women experiencing the greatest impacts. Unequal access, control and ownership over natural resources by women excludes them from important decision and policy-making institutions that govern the natural resources on which their livelihoods depend on. Governance and decision-making structures at all levels are still dominated by men. This is demonstrated by the absence of gender in policy frameworks involving the management and protection of

[156] Economic Consulting Associated/Dorsch International Consultants/Brian Colquohoun, Hugh O'Donnel and Partners. 2013. Zimbabwe: Water sector investment Analysis: Full Technical Report, Harare, Zimbabwe.
[157] Gender analysis for the GCF feasibility study and proposal
[158] ZIMSTAT. 2014. ZIMSTAT. Available on: http://www.zimstat.co.zw/ (Accessed 5 May 2017)
[159] ZimVAC. 2013. Zimbabwe Vulnerability Assessment Committee 2013 Rural Livelihoods Assessment. SIRDC. ZimVAC, Harare.

environment and natural resources in Zimbabwe[160]. Further, the impacts of climate change will continue to widen the gap between and exacerbate existing inequities between women and men (Table 6). For example, recurring droughts and low rainfall patterns have impacts on accessible water supplies and fuel wood, especially in rural areas, which increases the distances that women and girls have to walk to secure these resources. This increases the time women will have to spend walking to fetch fuel, limiting the time they would have available to invest in themselves, and also increases security risks. Women are also particularly vulnerable to the knock-on effects of climate change. For example, women in some areas of Shurugwi district in Masvingo province reported that a shift in livelihood strategies to beer brewing (more resilient to climate variabilities), led to higher alcoholism and an increase in domestic violence and abuse against women.

Table 6: Vulnerability of women to climate change in Zimbabwe. *Source:* Brown et al. (2012). Climate change impacts, vulnerability and adaptation in Zimbabwe. Climate Change Working paper No.3: December 2012

| **Climate Impact** | **Underlying socio-economic risk factors** | **Vulnerability of women** |
|---|---|---|
| Crop failure | 70% of women in Zimbabwe are smallholder farmers | Strain on food provision<br>Increased agricultural workload |
| Shortage of safe, clean drinking water | Gendered division of household labour | Additional time required to travel greater distances to collect water from alternative sources, which may not be clean/ safe<br>Exposure to violence / sexual abuse when travelling to and from water sources |
| Disease | Gender division of reproductive labour/ care<br>giving<br>Cultural restrictions on mobility | Additional time required to care for young, sick and elderly<br>Women of all ages lack access to health care<br>Services |
| Migration | Males may contribute little to household income (e.g. remittances).<br>Women who become de facto household heads may face difficulties in retaining control over land and other productive assets due to unequal property and land rights | Increased domestic / agricultural workload<br>Decreased coping capacity and insecure<br>tenure |
| Disaster | Women and children often lack skills, knowledge and resources | Women and children are more likely to die than men during disaster events |
| Displacement | Particular problems in temporary housing /relocation sites | Women and young girls face higher rates of sexual abuse and violence |
| Resource scarcity | Women have lower levels of educational attainment<br>Women are over-represented in the informal sector<br>Women earn lower wages and have limited access to markets | Limited time and resources to invest in more resilient land and shelter.<br>Limited resources to invest in alternative livelihoods |

Gender and other vulnerabilities tend to coincide: women are more vulnerable to social problems including unemployment and HIV/AIDS. Although Zimbabwe has made significant strides towards the reduction of HIV prevalence, levels remain significantly high at 15% in 2010/11, and as far as reporting rates go, women have higher HIV/AIDS rates than men (18% to 12% respectively). Also, as gender roles require women to care for the sick and the orphans, and their role as primary caregivers in the HIV/AIDS pandemic places a severe strain on their capacity to cope. This will be exacerbated by the increase in climate change-related diseases.

The disabled are another particularly vulnerable group. People Living with Disability (1.4 million) constitute approximately 10% of Zimbabwe's total population[161]. Households with disabled members have lower mean income, which, while other indicators are also important, impacts their ability to cope in the face of climate risks. The 2012 National Census revealed that elderly people (65 years and above) also find it difficult to cope with

[160] Chagutah, T. 2010. Climate Change Vulnerability and Preparedness in Southern Africa: Zimbabwe Country Report. Heinrich Boell Stiftung, Cape Town.
[161] DFID. 2007. Disability Scoping Study. Available on: https://www.ucl.ac.uk/lc-ccr/downloads/scopingstudies/dfid_zimbabwereport (Accessed 18 July 2016)

climate-related extreme events or participate in adaptation initiatives to mitigate risks because of their advanced age and home confinement[162].

## 1.8 Vulnerabilities to climate change and solutions for building resilience

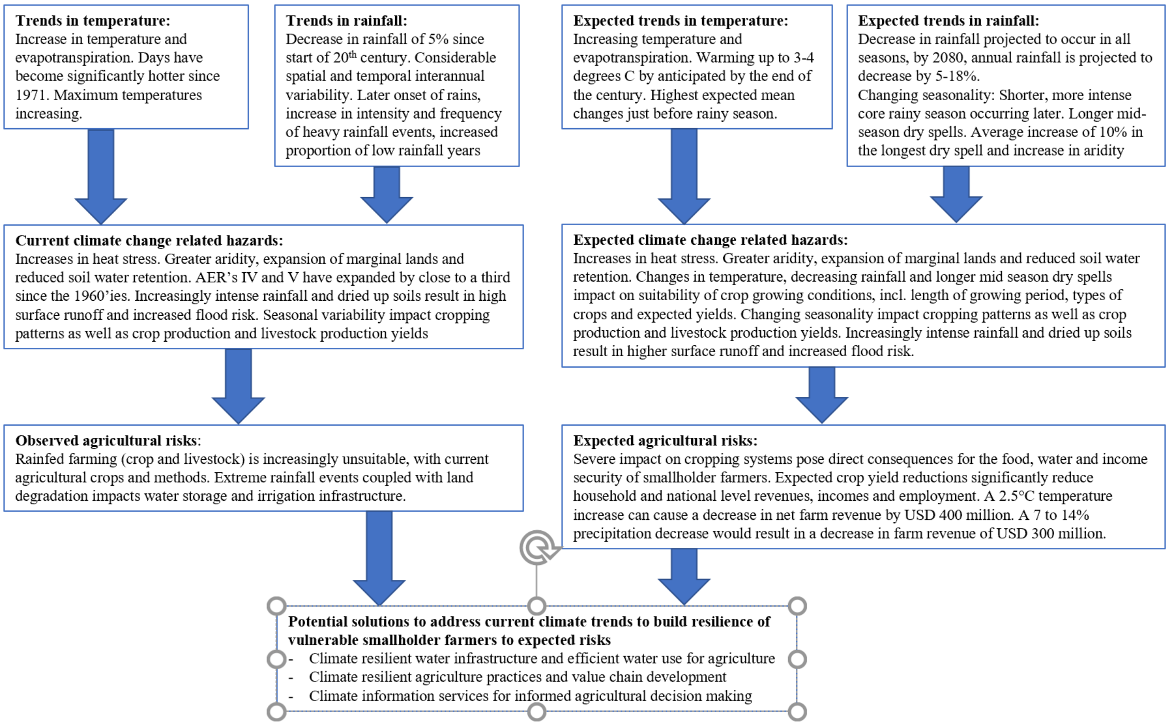
In summary, the current and expected changes in climate and the related impacts on the agriculture sector and agricultural livelihoods are presented below:

| Expected change in climate | Corresponding climate hazard | Impact on agriculture |
|---|---|---|
| Increase in temperature and evapotranspiration | Increases in heat stress. Greater aridity, expansion of marginal lands and reduced soil water retention.<br>Changes in suitability of crop growing conditions, incl. length of growing period. | The increasing temperatures and evaporation results in crops being exposed to heat and water stress, which is likely to lead to crop failure in rain-fed farming systems.<br>Increasing temperatures also affect the distribution of diseases, which are a major cause of cattle loss across the country.<br>Reduced availability of water for irrigation and rainfed crops. In the absence of irrigation technologies for harnessing water and limited use of effective water and moisture conservation practices in rain-fed farming systems, climate-induced water stress may force more smallholders into stream-bank cultivation, which in turn contributes to land degradation and siltation of water bodies, water storage and irrigation infrastructure. |
| Decrease in rainfall to occur in all seasons | Greater aridity, expansion of marginal lands and reduced soil water retention.<br>Changes in suitability of crop growing conditions, incl. length of growing period. | |
| Changing seasonality:<br>- Shorter, more intense core rainy season occurring later<br>- Longer mid-season dry spells. Average increase of 10% in the longest dry spell and increase in aridity | Increasingly intense rainfall and dried up soils result in high surface runoff and increased flood risk. | Extreme flooding events can lead to harvests being washed away and increased damage to infrastructure, such as roads, bridges, irrigation, and agricultural processing and storage facilities. |
| | Seasonal variability impact cropping patterns as well as crop production and livestock production yields | The increasing frequency of mid-season dry spells results in crops being exposed to severe heat stress during the harvesting season, which is likely to lead to crop failure in rain-fed farming systems. Similarly, increased heat stress, lack of feed and limited water resources is likely to lead to more livestock deaths.<br>Yield reductions in crops, particularly cash crops, will significantly reduce household and national level revenues, incomes and employment |

[162] ZIMSTAT. 2012. Zimbabwe Population Census 2012. Population Census Office. ZIMSTAT.

The changes in climate significantly impact smallholder farmers on dryland, especially women, threatening food and income security owing to climate induced water scarcity and declining agricultural production. Potential benefits from years of investment in smallholder rural irrigation development intended to boost food production have not been realised or have been lost due to climate induced dry spells, high temperatures, as well as flooding and torrential rains. Considering Zimbabwe's significant levels of vulnerabilities in the agricultural sector, the following potential solutions were selected for this feasibility study to focus on:

- Climate resilient water infrastructure
- Climate resilient agricultural practices and value chain development
- Climate information services for informed agricultural decision making




## 1.9 Vulnerability to climate change: Geographical targeting

Based on consultations with Government of Zimbabwe and other key stakeholders , the above described analysis of historic climate data and projected climate risks and the analysis of climate change impacts on agricultural livelihoods, it is recommended that the focus of the project should be on the three southern provinces, Matabeleland South, Masvingo and Manicaland, and in particular on districts based in the Save, Runde and Mzingwane river basins given their significant vulnerability to climate change. In line with this analysis, the Climate Resilient Irrigation Sub-assessment undertook an analysis of irrigation schemes in this area and employed a selection approach that mapped irrigation potential against climate vulnerability and poverty. This sub assessment identified 52 potential irrigation sites (see Figure 25) and annex 8 for a detailed methodology.

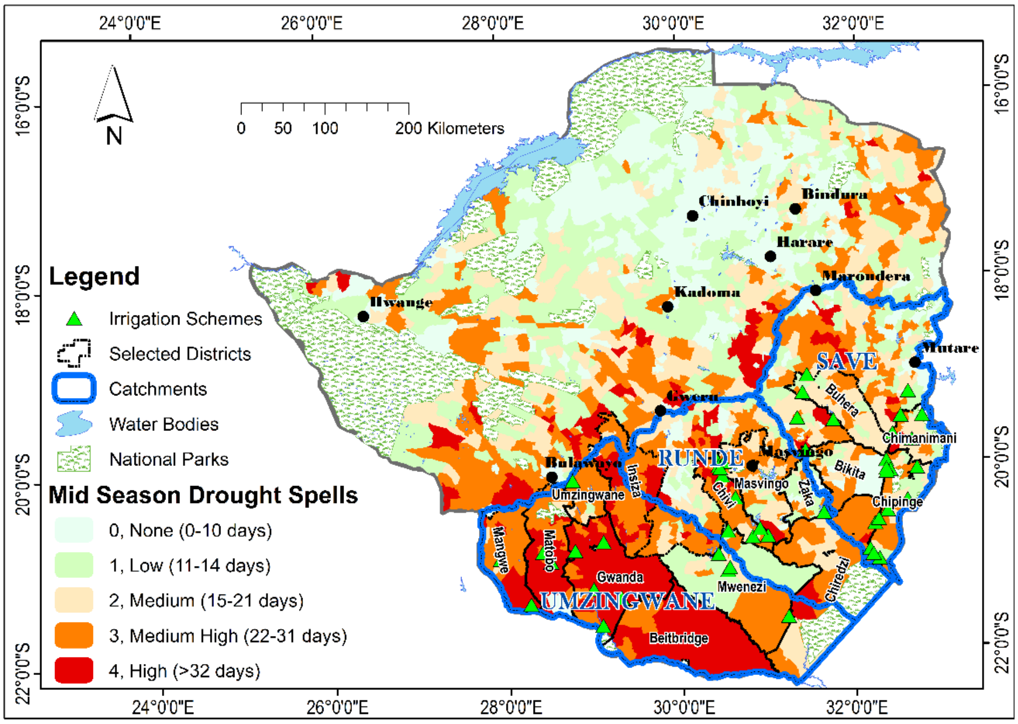



Figure 25: Proposed irrigation schemes mapped against  mid-season dry spell risks (based on Zimbabwe Resilience Building Fund data).

Simultaneously, the Value Chain Sub-assessment identified priority ‘climate resilient’ value chains in the southern provinces, mapping market demand, including proximity to buyers, availability of inputs, storage and post-harvest management requirements as well as potential for climate resilient crop and livestock production to be expanded. This mapping took into account the experience of farmers in growing crops to utilise local, indigenous knowledge, and the agro-ecological conditions across the southern provinces.

Building on these analyses, the Climate resilient agriculture Sub-assessment consulted key stakeholders in government, research institutions and farmers on the agronomic suitability, challenges and opportunities of the priority crops and livestock combinations identified for the climate resilient value chains in combination with the selected vulnerable areas. The CRA Sub-assessment  determined successful baseline experiences for promoting climate smart agricultural practices and developing value chains to take into account climate resilience considerations. The focus was on matching the proposed crop-livestock combinations analysed in the value chain sub assessment with the relevant CRA practices to strengthen the adaptive capacities of smallholders to climate change. The CRA package consultations also served as a space for validating the choice of irrigation schemes with AGRITEX Officers and provided important information on priority districts and wards for implementation of the proposed CRA packages.

The prioritisation of districts and wards was based on the occurrence of mid-season dry spells as identified by the ZRBF hazard mapping of historic climate vulnerabilities and AGRITEX extension officers’ experiences of district and ward climate vulnerability levels. This targeting exercise identified 15 priority districts, with a total of 386 wards, and 137 priority wards in the southern provinces (tabulated in

Table 8). MLAWCCR recommended to focus on contiguous districts in each province and in at least 50% of the wards to ensure maximum effectiveness.

Table 8 shows the demographic characteristics of the proposed districts. It shows that these districts comprise of 386 wards in total accounting for 2,362,683 people, of whom, 2,302,121 people reside in rural areas. It is estimated that the majority of wards across the 15 districts will benefit from a component on climate information services. Out of the total number of wards, 137 climate vulnerable wards have been proposed for implementation of CRA packages with a total population of 751,935 persons and an estimated total rural population of 543,619.Out of the wards selected for implementation of CRA packages, the irrigation schemes based in most climate vulnerable wards were selected.  Based on this analysis, 21 wards will benefit from investments in irrigation schemes, reaching out to an estimated 5,899 households and 29,495 people.

Table 7: Proposed project districts

| Province | District |
|---|---|
| Manicaland / Save catchment area | Buhera, Chipinge, Chimanimani |
| Masvingo / Runde catchment area | Masvingo, Chivi, Bikita, Zaka, Chiredzi, Mwenezi |
| Matabeleland South / Umzingwane | Umwingwane, Matobo, Mangwe, Insiza, Gwanda, Beitbridge |

Table 8: Population in Manicaland, Masvingo and Matebeleland South districts.

*Source*: Computed from Zimstat (2012), Poverty Atlas (2015), ZRBF hazard mapping

| Province | District | Total number of wards per district | Total population | Total rural population | District % of poor population |
|---|---|---|---|---|---|
| Matabeleland South | Beitbridge Rural | 15 | 80,083 | 80,083 | 68,0% |
| | Gwanda | 24 | 115,778 | 112,999 | 69,7% |
| | Insiza | 23 | 100,333 | 100,333 | 77,1% |
| | Mangwe | 17 | 66218 | 65,821 | 73,2% |
| | Matobo | 25 | 93940 | 93,376 | 76,6% |
| | Umzingwane | 13 | 62990 | 62,612 | 82,1% |
| **Total** | | **117** | **519,342** | **515,224** | |
| Masvingo | Bikita | 32 | 162,365 | 158,793 | 72,1% |
| | Chivi | 32 | 166049 | 145,127 | 65,8% |
| | Chiredzi | 32 | 275759 | 275,483 | 62,5% |
| | Masvingo | 35 | 211,215 | 205,301 | 54,1% |
| | Mwenezi | 18 | 166993 | 162,651 | 80,9% |
| | Zaka | 34 | 181,301 | 181,120 | 69,6% |
| **Total** | | **183** | **1,163,682** | **1,128,475** | |
| Manicaland | Buhera | 33 | 245,878 | 238,993 | 78,0% |
| | Chimanimani | 23 | 134940 | 128,058 | 76,8% |
| | Chipinge | 30 | 298,841 | 291,370 | 79,6% |
| **Total** | | **86** | **679,659** | **658,421** | |
| **Grand Total** | | **386** | **2,362,683** | **2,302,121** | |

Table 9 provides an overview of the number of targeted wards and total target ward population. In addition Figure 26 provides an overview of targeted wards mapped against risks of mid-season dry spells and proposed irrigation schemes.

Table 9: Target wards and population

| **Overview of number of wards and target population** | | | | |
|---|---|---|---|---|
| **Province** | **District** | **Number of targeted wards** | **Total target ward population** | **Total estimated population depending on agricultural livelihoods in target wards** |
| Matabeleland South | Beitbridge | 5 | 19,591 | |
| | Gwanda | 13 | 72,793 | |
| | Insiza | 16 | 66,307 | |
| | Mangwe | 6 | 23,597 | |

| | | | | |
|---|---|---|---|---|
| | Matobo | 16 | 67,590 | |
| | Umzingwane | 7 | 26,527 | |
| **Total** | | **63** | **276,405** | **193483** |
| Masvingo | Bikita | 4 | 16,326 | |
| | Chiredzi | 8 | 58,316 | |
| | Chivi | 9 | 45,286 | |
| | Masvingo | 5 | 50,591 | |
| | Mwenezi | 9 | 30,241 | |
| | Zaka | 4 | 17,368 | |
| **Total** | | **39** | **218,128** | **152689** |
| Manicaland | Buhera | 13 | 101,484 | |
| | Chimanimani | 7 | 34,019 | |
| | Chipinge | 15 | 146,563 | |
| **Total** | | **35** | **282,066** | **197446** |
| **Grand Total** | | **137** | **776,599** | **543619** |

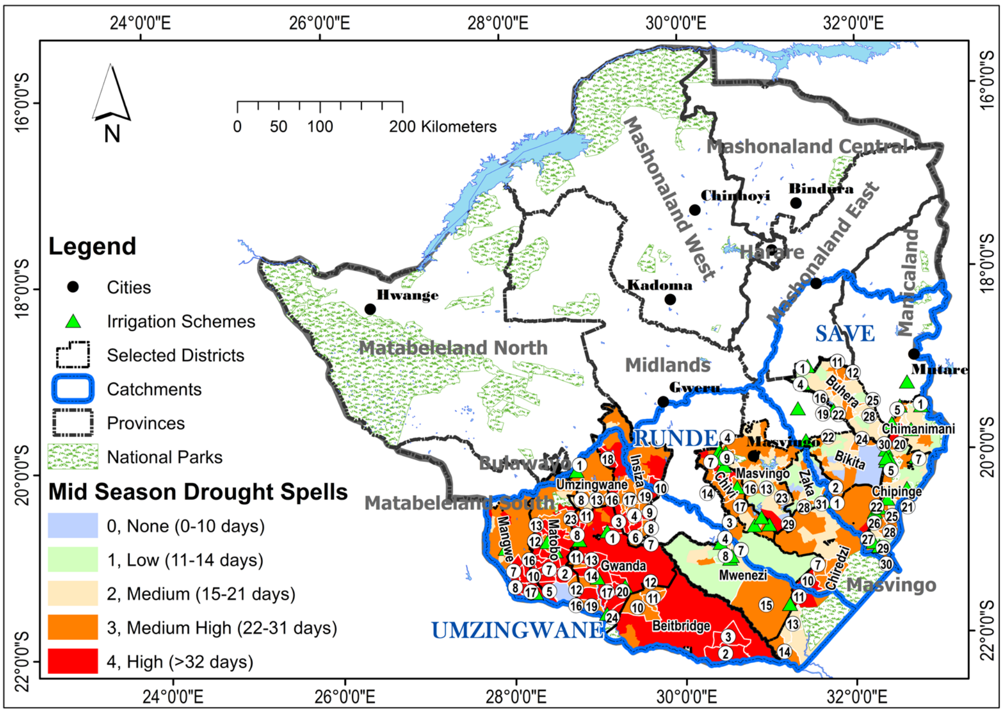



Figure 26: Proposed project districts, climate vulnerable wards and irrigation schemes

# 2 Policy and institutional frameworks related to agriculture

This chapter presents an overview of the policy and institutional frameworks relevant to water and irrigation, agriculture and climate services to understand who delivers services to smallholder farmers and how they are provided. The chapter is divided into an overview of policies and strategies and an analysis of relevant institutions and institutional frameworks.

## 2.1 National development policies and strategies

### *2.1.1 Zimbabwe Agenda for Sustainable Socio-Economic Transformation*

The Zimbabwe African National Union Patriotic Front (ZANU PF) Government has put in place a five-year economic blueprint plan: the Zimbabwe Agenda for Sustainable Socio-Economic Transformation (ZimAsset), with a vision to move "towards an empowered society and a growing economy", scheduled to run from 2013 to 2018[163]. ZimAsset is a cluster based plan, where areas of the economy are grouped together to integrate policies across Ministries and departments. The plan has four clusters: a) Food Security and Nutrition; b) Social Services and Poverty Eradication; c) Infrastructure and Utilities; and d) Value Addition and Beneficiation, with two sub-clusters: Fiscal Reform Measures and Public Administration, Governance and Performance Management. In 2015, GoZ delivered a Ten Point Plan to support operationalisation of ZimAsset, which includes developing the agriculture value chain, developing water infrastructure and encouraging private sector investment.

ZimAsset recognises agriculture as a key productive economic sector to generate growth and create employment. Programming across clusters is geared to strengthen agriculture. For example, the Food Security and Nutrition Cluster includes rehabilitation of irrigation infrastructure and promotion of drought resistant, high yielding and heat tolerant crop varieties; and the Value Addition and Beneficiation cluster includes investment in agriculture and agro-processing value addition activities. ZimAsset recognises that 'climatic changes affect the country's agro-based economy'[164] and identifies 'climate change policy' as a cluster output for the key result areas on policy and legislation and environmental management[165].

Eradicating poverty is a top priority of the ZimAsset and UNDP has supported the development of an Interim Poverty Reduction Strategy Paper for Zimbabwe (IPRSP): 2016-2018 to support implementation of poverty reduction interventions consistent with the visions set out in ZimAsset. It is expected that a full Poverty Reduction Strategy Paper (PRSP) will be developed and anchored on a successor programme to Zim Asset. The IPRSP is also part of current efforts for re-engagement with international donors and banks.

### *2.1.2 Transitional Stabilisation Programme*

The ZimAsset was followed by the Transitional Stabilisation programme as the national economic blueprint for the period 2018-2021. The TSP acknowledges that "The devastating effects of climate change faced by the region in recent years requires interventions towards enhancing climate resilience, in particular rain fed agriculture, central to food security and livelihoods of the rural population".[166] Its targets in relation to SDG 13 include:

- Integrating climate change issues into national policies, strategies and planning and strengthen resilience and adaptive capacity to climate related hazards and natural disasters;
- Increasing adaptation capacity;
- Strengthening early warning systems; and
- Promoting mechanisms for raising capacity for effective climate change related planning and management, to reduce exposure of such susceptible groups as women, youths, and marginalised communities.

The TSP recognises the role played by the Zimbabwe Resilience Building Fund in capacitating vulnerable rural communities to withstand shocks, ultimately reducing dependency on humanitarian responses.[167] In relation to

[163] GoZ. 2013. ZimAsset (2013-2018). GoZ, Harare, p.7.
[164] GoZ. 2013. ZimAsset (2013-2018). GoZ, Harare, pp. 24-25.
[165] GoZ. 2013. ZimAsset (2013-2018). GoZ, Harare, p.57.
[166] TRANSITIONAL STABILISATION PROGRAMME: REFORMS AGENDA (October 2018 October 2018 – December 2020), p 197.
[167] TRANSITIONAL STABILISATION PROGRAMME: REFORMS AGENDA (October 2018 October 2018 – December 2020), p 198.

irrigation and water management, the TSP recognises that irrigation development initiatives will also assist drought proofing rural communities and it promotes climate resilient water management systems.[168]

### *2.1.3 The Revised National Gender Policy (2017)*

The revised National Gender Policy (NGP) from 2017 provides a broad framework to guide and coordinate all efforts for addressing gender inequality and discrimination in Zimbabwe and calls for gender justice, equality, integration, inclusiveness and shared responsibility for sustainable development in Zimbabwe. One of its 10 priority thematic areas is Gender, Environment and Climate Change, which promotes assessments of gendered vulnerabilities to climate change impacts and design of climate change adaptation interventions with gender equality in mind. The process of developing the NGP was supported by UNDP and UN Women.

### *2.1.4 Climate change policies*

Climate change considerations are increasingly being mainstreamed into new policy. The Renewable Energy Policy is the most recent example, and several sectoral policies and strategies cover issues around climate change, including the National Policy and Programme on Drought Mitigation; the Draft Disaster Risk Management Policy and Strategy; the Second Science, Technology and Innovation Policy 2012; the Water Policy, the Agriculture Marketing and Pricing Policy and the Small, Micro and Medium Enterprises Policy. While the National Climate Policy (2017) provides an overall policy framework for climate change, there are practical coordination challenges to deliver a coordinated response to climate change impacts.

#### *2.1.4.1 National Climate Change Response Strategy*

The National Climate Change Response Strategy (NCCRS) (2014) provides the strategic framework and response plan to deal with climate change impacts. The goal of the strategy is to mainstream climate change adaptation into planning across sectors and institutional levels in a coordinated manner, through multi-stakeholder engagement. For 'agriculture and food security', key actions presented are: sustainable intensification and commercialisation of agriculture; strengthened capacity of agricultural support services, and increased agriculture specialisation according to AERs.

#### *2.1.4.2 Zimbabwe's Nationally Determined Contribution*

Zimbabwe's Nationally Determined Contribution (NDC) (2015) highlights the agriculture sector as the country's core vulnerability to climate change[169]. Adaptation in the agricultural sector is stated as a 'national priority, demanding policy direction at the highest level'[170]. Activities encouraged include the promotion of adapted crop and livestock development and CRA practices; resilience building in managing climate related disaster risks such as droughts; and strengthened management of water resources and irrigation in the face of climate change. The recently developed NDC Implementation Framework (2019) and the Low Emission Development Strategy (2019) outlines the practical implementation of mitigation ambitions, economy wide, and includes a focus on the Agriculture, Forestry and Other Land Use Sector as one of the key sectors of mitigation in Zimbabwe. Conservation agriculture is promoted as one of the central mitigation options.

#### *2.1.4.3 National Climate Policy*

The National Climate Policy (NCP) follows the NCCRS and provides the **policy framework** for climate change action in Zimbabwe. It aims to achieve coordinated delivery of strategic responses to climate change among GoZ departments, for them to guide effective implementation with key stakeholders, including research institutes, NGOs, international donors and private sector actors[171]. Agriculture and water are considered key sectors to develop adaptive capacity to climate change[172]. Responses in the sectors include: integration of climate change analyses into the planning and design of irrigation investment; promotion of irrigation and water use efficiency in agriculture, including adequate assessment of irrigation potential and irrigation demand under climate change; and promotion of sustainable land-use systems in line with principles of Climate resilient agriculture (CRA).

[168] TRANSITIONAL STABILISATION PROGRAMME: REFORMS AGENDA (October 2018 October 2018 – December 2020), p 199.
[169] UNFCCC. 2015. Zimbabwe's Intended Nationally Determined Contribution (INDC). Available on: http://www4.unfccc.int/submissions/INDC/Published%20Documents/Zimbabwe/1/Zimbabwe%20Intended%20Nationally%20Determined%20Contribution%202015.pdf (Accessed 18 July 2016)
[170] Ibid, p.2.
[171] MLAWCCR. 2016. National Climate Policy 2017. GoZ, Harare.
[172] Ibid.

### *2.1.4.4 The Low Emission Development Strategy*

The Low Emission Development Strategy provides guidance on how Zimbabwe may implement its energy focused NDC's and expand the NDC's to cover key sectors across the economy, including agriculture. The Agriculture, Forestry and other Land Use sector is the second largest source of GHG emissions in the country. Along with stopping net-deforestation by 2030, the most important intervention in the sector is to promote the use of conservation agriculture, which increases soil organic carbon, supports adaptation and increased revenues from farming and livestock management. According to the strategy projections, conservation agriculture accounts for almost 28% of Zimbabwe's accumulated abatement potential by 2050.

### *2.1.4.5 The National Adaptation Plan*

The Government of Zimbabwe has accessed readiness funding for the Building Capacity to Advance National Adaptation Planning project through the Green Climate Fund. It is expected that the country will have a National Adaptation Plan in place by 2021.

### *2.1.4.6 Renewable Energy Policy*

The Renewable Energy policy advocates for a larger share of renewables in the national energy mix, incentives for renewable energy investments and access to sustainable energy for all. This includes a focus on off-grid renewable energy technologies for areas that will not be reached by the grid in the near future (as mapped out in the Rural Energy Master Plan 2017) and may include solar technology for use by both farmers and national authorities. Zimbabwe is also implementing the African Development Bank's Sustainable Energy for All Action Agenda (SE4ALL AA) and Investment Plan (IP)[173], which have informed development of the REP.

### *2.1.4.7 Environmental Management Act*

The Environmental Management Act (EMA) of 2002 is a framework legislation that establishes coordinated legal and institutional mechanisms to improve national capacity for management of the environment across sectors[174]. It provides for the Environmental Management Agency to manage all environmental issues in the country, including water quality and monitoring, land degradation and pollution management, which operates at national, provincial and district levels. It includes a provision for the establishment of an Environment Fund, used to provide environmental management services across the country. It stipulates Environmental Impact Assessments (EIA) to be undertaken in certain projects.

## ***2.1.5 Agriculture policies***

### *2.1.5.1 Comprehensive Agricultural Policy Framework*

The Comprehensive Agricultural Policy Framework lays out a situation analysis of the agricultural sector and identifies broad policy goals for the period 2012-2032. It states that the 'performance of the agricultural sector determines the overall level of people's living standards and development of the economy'[175]. Its three main focus areas are: i) increasing crop productivity and diversification, ii) increasing livestock production and iii) increasing access to irrigation. Other focus areas include input supply, trade, and strengthening agricultural extension and research, to make sure all agricultural actors are well integrated into market systems. The Comprehensive Agricultural Policy Framework also includes an intention on mainstreaming gender considerations into agriculture.

### *2.1.5.2 Zimbabwe Agricultural Investment Plan*

The Zimbabwe Agricultural Investment Plan (ZAIP) (2013-2018) is the shared national framework for coordinating public, private and development partners' investment into the agriculture sector, aimed at achieving the objectives of the Comprehensive Agriculture Policy Framework (2012-2032), ZimAsset (2013-2018) and the

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[173] AfDB. 2016. Validation of the Zimbabwe Sustainable Energy for All Action Agenda. Available on: https://www.afdb.org/en/news-and-events/validation-of-the-zimbabwe-sustainable-energy-for-all-se4all-action-agenda-16281/ (Accessed 18 July 2016)
[174] EMA. 2002. Environmental Management Act 13 of 2002. Amended by Act 5/2004. GoZ, Harare.
[175] MLAWCCR. 2012. Comprehensive Agricultural Policy Framework (2012-2032). GoZ, Harare, p.1.

Food and Nutrition Security Policy (FNSP) (2012)[176]. It was prepared by MLAWCCR, and is aligned to meet the country's commitments made under the Comprehensive Africa Agricultural Development Program (CAADP) to allocate at least ten percent of the national budget to the pursuit of a sustained six percent agricultural growth rate[177]. ZAIP recognises that the agricultural sector has undergone massive changes, leading to an increased number of farmers and relatively smaller sizes of farms, which are operating at sub-optimal levels[178]. For the sector to operate viably and profitably for farmers and the economy, ZAIP's 'strategic thrust' focuses on supporting farmers to become an integral part of domestic and export value chains[179]. ZAIP states that 'productive and competitive capacities of farmers as well as capacities of public institutions which support farmers need to be built across different commodities so that farmers can participate competitively and supply both domestic and export markets'[180]. Climate change is highlighted as one of the major risks to the development of the agriculture sector[181]. As reflected in ZAIP's budget, priority activities include rehabilitation of irrigation, rehabilitation of existing priority sources of water (dams, rivers, boreholes) for irrigation, and strengthening farmer associations' and lead farmers' capacity and in-service training for public extension staff[182]. The ZAIP also includes a focus on gender mainstreaming to ensure balanced power dynamics between men and women in access, control and ownership of agricultural assets.

#### *2.1.5.3 Food and Nutrition Security Policy*

The Food and Nutrition Security Policy (2013) was developed to ensure food and nutrition security for all people at all times, particularly the most vulnerable[183]. It provides a framework to inform the establishment and strengthening of national structures, mechanisms and capacities to facilitate multi-disciplinary, broad-based collaborative approaches for addressing food and nutrition security[184]. Agricultural development is seen as a key component, allocated to MLAWCCR, and various strategic objectives include: increased agricultural production capacity and diversification among farmers, particularly women; strengthened post-harvest management; and investing in value-addition activities[185]. The Zimbabwe National Nutrition Strategy (2014-2018) was launched in 2014 to support implementation of the Food and Nutrition Security policy.

### *2.1.6 Water and irrigation policies*

#### *2.1.6.1 Water Act and the Zimbabwe National Water Authority Act*

The Water Act and the Zimbabwe National Water Authority (ZINWA) (1998), govern management of the nation's water resources[186][187]. Water resource management arrangements are based on Zimbabwe's seven catchments. The Water Act (1998) includes a statutory instrument that **decentralises the allocation of surface water and groundwater** to the seven Catchment Councils (one per river basins). The ZINWA Act establishes the Zimbabwe National Water Authority and a Water Fund, financed by water user levy proceeds and an allocation from Parliament, to manage and develop water resources[188].

The Acts are based on Integrated Water Resource Management (IWRM) principles, which include integration, decentralization, participation, and treating water as a scarce resource with an economic and social value. They recognize the environment as a legitimate water user and are built upon the concepts of 'user pays' and 'polluter pays', to manage water use and regulate water pollution[189].

[176] MLAWCCR. 2013. ZAIP (2013-2018). A Comprehensive Framework for the Development of Zimbabwe's Agriculture Sector. GoZ, Harare.
[177] NEPAD. 2003. Comprehensive Africa Agriculture Development Programme (CAADP). Available on: http://www.nepad.org/programme/comprehensive-africa-agriculture-development-programme-caadp (Accessed 18 July 2016)
[178] MLAWCCR. 2013. ZAIP (2013-2018). A Comprehensive Framework for the Development of Zimbabwe's Agriculture Sector. GoZ, Harare.
[179] Ibid.
[180] Ibid, p.47.
[181] Ibid.
[182] Ibid.
[183] FNC. 2013. Food and Nutrition Security Policy. GoZ, Harare.
[184] Ibid.
[185] Ibid.
[186] GoZ. 1998a. Water Act [Chapter 20: 24], Government Printers: Harare.
[187] GoZ. 1998b. Zimbabwe National Water Authority. [Chapter 20: 25] Harare, Zimbabwe.
[188] GoZ. 1998a. Water Act [Chapter 20: 24], Government Printers: Harare.
[189] MWRDM. 2012. Water resources development and management background paper: Towards a water secure Zimbabwe: Improving governance and utilisation of water resources, Background paper for the National Water Policy for Zimbabwe. GoZ, Harare.

#### 2.1.6.2 National Water Policy

The National Water Policy (NWP) (2013) was put in place to guide implementation of the Water and ZINWA Acts (1998) (above) and all aspects of water resource development and management, including protection. Its objectives include: equity in access to freshwater by all Zimbabweans; efficient use of water among competing users; protection of water sources; consumer and institutional accountability; and economic development[190]. It makes a comprehensive attempt at internal harmonisation by clarifying roles and responsibilities of the various institutions within the water sector, as well as how management of the sector should be coordinated with other sectors. It states that 'in view of the projected negative impacts of climate change on water resources, ZINWA and Catchment Councils will integrate climate change into all water resource planning and design activities'[191].

## 2.2 Institutional frameworks

### 2.2.1 Climate institutions

#### 2.2.1.1 Climate Change Management Department

The **Climate Change Management Department** (CMD) of the Ministry of Lands, Agriculture, Water, Climate and Rural Resettlement (MLAWCCR) has the mandate to coordinate national climate change action[192]. It has grown from a relatively small and understaffed department, to a well-functioning team that covers issues related to adaptation, mitigation and DRM[193]. It has effectively pushed through policies and strategies on climate change issues, as evidenced by the NCCRS and the National Climate Policy, and has inputted to the integration of climate change considerations in sectoral policies. It also mainstreamed climate change in ZAIP and has been part of the development of a national CRA framework and manual. It liaises with several development partners, donors and other actors on projects related to climate change.

#### 2.2.1.2 Meteorological Services Department

The **Meteorological Services Department** (MSD) of the MLAWCCR provides meteorological, climatological and seismological products to be made available to major users, such as the aviation, agriculture, energy, defence, tourism and water resources industries[194]. To collect the information necessary to provide this service, MSD operates **64 meteorological (MET) stations** around the country, which provide meteorological data (rainfall, temperature, winds, humidity etc.) on a semi-regular basis (depending on the type of stations and whether they are manually operated or automatically transmit data to a central server). The data is primarily used to develop and adjust weather forecasts, as well as being used to understand the climate of Zimbabwe. Three types of MET stations are utilised (synoptic, agrometeorological/climate and rainfall-only): **synoptic** stations are used to communicate synops reports to the WMO (exchanged regionally and internationally) at fixed times; **agromet/climate** stations are used to monitor meteorological conditions for agriculture and climate purposes; and **rainfall-only** stations are used to collect rainfall data (manually recorded by observers). MSD operates 47 **manual synoptic** stations dotted around the country, 30 of which are manned by MSD staff and 17 by agricultural extension officers. There are only 17 **Automatic Weather Stations** (AWS) installed. These are complemented by 300 voluntary **rainfall-only** stations. Annex 9 provides the location of MET stations in the Save, Runde and Mzingwane catchments, as well as details of how weather and seasonal forecasts are produced.

To disseminate information and products, MSD has established links with Farmer Unions and organizations at national and provincial levels, through the provincial offices and the Farmers Guardian newsletter. The Department holds the **National Climate Outlook Forum** annually, where interested stakeholders are invited and the seasonal forecast is presented. These forums are a platform that can be used to strengthen linkages with the various Farmers Unions and organizations in the country.

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[190] Sixteen key principles provide the foundation for detailed sub-sector policies and planning in line with water and water-related priorities. These principles are informed by the SADC Regional Water Policy and more or less cover the nine thematic areas mirroring the SADC Policy. The policy also refers to international and regional conventions and frameworks.

[191] MWRDM. National Water Policy. 2012. GoZ, Harare, p.22.

[192] GoZ. 2017. Climate Change Management Department. Available on: http://www.climatechange.org.zw/ (Accessed 18 July 2017)

[193] Through support from UNDP's Scaling Up Adaptation Programme (2015-2018) and Supporting Climate Action for Low Emission, Climate Resilient Development project (2016-2020).

[194] GoZ. 2017. MSD. Available on: http://www.environment.gov.zw/index.php/blogs/departments/meteorological-services-department (Accessed 18 July 2016)

#### 2.2.1.3 *The Department for Civil Protection*

The Department for Civil Protection (DCP) falls under the Ministry of Local Government, Rural Development and National Housing. The DCP is mandated with the overall coordination of all stakeholders involved in disaster risk management, promotion of preparedness planning and early warning systems, emergency response and early recovery, and advocacy for integration of disaster risk reduction into development planning and interventions.

### ***2.2.2 Agriculture and value chain institutions***

#### 2.2.2.1 *Department of Economics and Markets*

The Department of Economics and Markets plays a key role in coordinating agricultural policy. It is the only department, which can act on behalf of the Permanent Secretary of the Ministry of Lands, Agriculture, Water, Climate and Rural Resettlement and functions as the secretariat of the Ministry. It is responsible for drafting agriculture-related policy on behalf of MLAWCCR, which includes coordination of policy drafting with other departments, and conducts policy analysis and legal drafting of policy instruments[195]. It is also responsible for administering issues around marketing and trade, supporting the formation of national and international agricultural partnerships and monitoring and evaluation of agricultural projects. The Department of Economics and Markets is a key stakeholder in managing the Zimbabwe Resilience Building Fund, which is a multi-donor funded initiative under MLAWCCR, which provides a strong framework for mainstreaming climate risk analysis and a focus on resilience building for vulnerable rural communities into agricultural policy and interventions (see Chapter 3). The ZRBF has contributed to the development of a national Strategic Framework for Resilience in Zimbabwe which has formed the conceptual basis for the inclusion of resilience building considerations in the revised agricultural extension services policy. The CRA framework and the revision of the Rural Development Act is also informed by the Strategic Framework for Resilience to include climate change risk analysis and resilience building considerations.

#### 2.2.2.2 *Department of Agriculture, Technical and Extension Service*

The national extension service department, the **Department of Agricultural, Technical and Extension Service** (AGRITEX), hosted in MLAWCCR, is mandated to provide extension services to all farmers (rainfed crop and livestock and irrigation farmers), in collaboration with MLAWCCR's research institution, DR&SS (see below). It is responsible for providing planning, technical and agricultural extension services to farmers, including farmer training, food technology (including post-harvesting processing and product development), dissemination of technologies, and market oriented extension for sustainable farming[196]. To do this, AGRITEX deploys extension personnel to all farming systems across the country. Usually, three Extension Officers are allocated per ward, resulting in an Officer to farmer ratio 1 to 200. In rain-fed crop and livestock farming systems in regions that are not well suited for agriculture, namely AER IV and V, often only one Officer is allocated per ward. In Manicaland and Masvingo, AGRITEX has three Officers manning each ward, complimented by one livestock Officer. In Matabeleland, there is one AGRITEX Officer complimented by three livestock Officers per ward. However, structural changes currently being proposed may result in every ward, no matter the needs of the farming systems present, having only one Officer. Specialists in agronomy, irrigation, marketing, and veterinary services are also made available at the district level in a District Office, as part of AGRITEX's service.

Within AGRITEX there are three units: (i) **Agribusiness and Marketing Unit**, which is mandated to advise farmers on agribusiness and marketing, with personnel at Head Office and the provincial level; (ii) **Training Branch**, which offers a number of courses to train Extension Officers to train farmers in farming practices (see Annex 10 for details on courses), (however many AGRITEX Offices depend on NGOs to provide training, due to limited resources); and (iii) **National Early Warning Unit** (NEWU), mandated to monitor food security information to provide timely and accurate early warnings through the production of several reports (see Box 1, below). When the risks evolve into disasters, the Department for Civil Protection takes over.

The **NEWU** plays a coordinating role with regard to assessing agricultural production and food security. The Unit works across disciplines (agrometeorology, crops, livestock, economics and markets); ministries (Agriculture, Mechanisation and Irrigation Development; Environment, Water and Climate; and Finance and Economic Development); and non-state actors, such as FEWSNET and FAO. During 2006 to 2014, the NEWU was able to carry out its activities due to financial assistance from FAO and the Famine Early Warning Systems Network

[195] MLAWCCR. 2015. Report on Needs Assessment within the Department of Agricultural Economics and Markets. Compiled by: Odreck Mukorera. GoZ, Harare.

[196] MLAWCCR. 2017. AGRITEX. Available on: http://www.agritex.gov.zw/ (Accessed 18 July 2016)

(FEWSNET), through the Agriculture and Food Security Monitoring System (AFSMS), but is currently operating at sub-optimal capacity due to limited resources.

**Box 1: NEWU reports**

**Agrometeorological crop and livestock reports** – to monitor the progress of the season through several indicators, such as rainfall performance, cropped area, crop condition, availability of inputs and price, livestock condition, availability of grazing, availability of water supplies, livestock disease occurrence etc. The reports are compiled from information generated through Fortnightly Report Forms.

**Monthly Food Security Bulletins –** to monitor the food security situation in the country by updating the Food Balance Sheet (supported by COMESA), which focuses on potential changes to the cereal stocks from meeting requirements (human consumption, livestock consumption/industrial use, storage losses) against availability (stocks, production, imports) sectors.

**Agriculture and Food Security Monitoring System briefs –** produced periodically during the production season with data provided through approximately 228 sites, covering the rural districts of the country.

### *2.2.2.3 Department of Livestock*

The **Department of Livestock** (DL) in MLAWCCR is mandated to provide services to facilitate development of a sustainable livestock sector that contributes to 'food and nutritional security, employment and economic growth'[197]. Through research and development activities, it promotes tailored technologies and practices to livestock production suited to different environmental conditions across AERs. It runs livestock stations for the different areas: Matopos (AER IV), Makoholi (AER IV), Marondera (AER IIb) and Henderson (AER IIa[198].

### *2.2.2.4 Department of Research and Specialist Services*

The Department of Research and Specialist Services (DR&SS) is mandated to disseminate new technologies and relevant agricultural information generated from research to stakeholders involved in the agriculture sector. DR&SS operates a number of research institutes across the country (see Annex 11), which have very specific mandates and were conceived to be centres of excellence for that particular activity. In Mzingwane catchment, Matopos Research Institute, located in Matabeleland South province, specialises in rangeland and livestock production systems in AERs IV and V in the southwest of the country, with a focus on crossbreeding exotic breeds. The station also hosts a branch of ICRISAT, whose focus is on crop production and crop-livestock interaction in the dry environment of AER V (see Chapter 3). In Save catchment, the Lowveld Research Institute specialises in the development and testing of crop agronomy and horticulture, specifically targeted for very dry (semi-arid) environments that are typical of AER V of the Lowveld in the country. It is comprised of three stations: Save Valley, Chisumbanje and Chiredzi. In Runde catchment, the Makoholi Research Station, near Masvingo Town in Masvingo Province, undertakes research in rangeland and livestock production systems in AERs IV and V in the southeast of the country. It also hosts a crop productivity research unit. AGRITEX has been working in close collaboration with DR&SS on several projects on research themes related to the introduction of new seed varieties, seed multiplication, on farm research trials and demonstrations for adoption of new farming technologies and systems.

### *2.2.2.5 Department of Agricultural Education and Farmer Training*

The Department of Agricultural Education and Farmer Training oversees fourteen **Agricultural Training Colleges** affiliated to state Universities to train AGRITEX Officers on how to train farmers in agronomy. Seven of these are being run in conjunction with the Ministry of Youth Development, Indigenisation and Empowerment, in the training of students at certificate level under an apprentice program which is fully funded by GoZ. This became necessary in order for the Department to meet increased demand of personnel in AGRITEX. The colleges are key in training students in agriculture and a strategic institution for communal farmers to access knowledge, information and innovations in their agricultural practices. The colleges in the southern provinces are: Mushagashe (Masvingo) and Rupangwane (Chiredzi) in Masvingo province, Esigodini (Esgodini) in Matebeleland South and Magamba (Mutare) in Manicaland. The colleges have been severely constrained by a

[197] MLAWCCR. 2017. Department of Livestock. Available on: http://www.dlvs.gov.zw/ (Accessed 18 July 2016)
[198] ICRISAT. 2011. ICRISAR Eastern and Southern Africa 2011 Highlights. Crop-livestock Intensification Zimbabwe. Available on: http://oar.icrisat.org/6660/1/Crop-livestock_intensification_Zimbabwe.pdf (Accessed 18 July 2016)

number of challenges, including inadequate funding, a lack of training equipment, such as computers and textbooks, inadequate or a lack of farm machinery to train students, such as tractors, farm implements and vehicles.

#### *2.2.2.6 Food and Nutrition Council*

The Food and Nutrition Council (FNC) is the quasi-government institution under the Office of the President and Cabinet of Zimbabwe (OPC), mandated to promote a cohesive, multi-sectoral national response to prevailing household food and nutrition insecurity through its role as convener and coordinator[199]. The FNC targets vulnerable groups such as the sick, those living and affected with HIV-AIDS who need specialized nutritious diets, and women and children in particular[200]. It promotes small grains that are resistant to drought with higher nutritional value, as well as small livestock, to improve household nutrition.

### *2.2.3 Water institutions*

Organisation of institutions responsible for the water sector is according to their responsibilities for service provision, as stated in the Water and ZINWA Acts (1998) and the NWP (2013). There are four distinct areas of service: (i) water resource management; (ii) urban water supply and sanitation; (iii) rural water supply and sanitation; and (iv) irrigation. Discussed below are institutional arrangements for water resources management and irrigation.

#### *2.2.3.1 Water resource management institutions*

The Ministry of Lands, Agriculture, Water, Climate and Rural Resettlement (MLAWCCR) provides guidance on water policy matters to Government through the Department of Water Resources (DWR). The DWR assists the Ministry to carry out statutory functions including the development of water policies, laws and regulations and fixing the criteria for water allocation for the issue of permits by Catchment Councils. **ZINWA** is a parastatal institution that is responsible for carrying out and publishing hydrological and geographical surveys, including river flow and dam level monitoring, water related research, for the purposes of planning, developing, and exploiting water resources. It is also responsible for assisting Catchment Councils to plan and coordinate the development and management of water resources and providing technical support for them to do so. The main level at which ZINWA operates is the catchment level (through its seven Catchment Council offices).

ZINWA is also responsible for hydrological monitoring and flood monitoring through the Hydrology (Data & Research) Section (while technical aspects of flood monitoring is the responsibility of ZINWA, flood advisories and warnings are provided by MSD and the DCP). For ZINWA to effectively achieve its mandate, functional hydrological gauging stations are important to gather basic information upon which key water planning, design and management decisions are based. Most gauging stations are located around the central watershed with fewer stations in the southern and northern part of Zimbabwe. The sparse network compromises ZINWA's ability to monitor extreme weather events such as floods, which is worsened by the absence of equipment capable of real time monitoring. Lacking this vital infrastructure has negative consequences for smallholder irrigation schemes that are negatively impacted by floods.

**Catchment Councils** are responsible for producing 'Catchment Outline Plans' (COP) for their river systems and granting temporary permits (valid for a period of up to 20 years) for commercial users of water, under criteria set by the DWR (water use for non-primary purposes can only be accessed by permit holders). They also are responsible for regulating and supervising the exercise of rights to, and use of water in respect of its river system, and supervising Sub-Catchment Councils. Catchment Councils are composed of representatives of Sub-Catchment Councils in each catchment.

**Sub-Catchment Councils** are established by the Minister, also through a statutory instrument under the Water Act (1998), for any part of a declared river system that falls under the relevant Catchment Council. **The Sub-Catchment Councils are the operational arm of the Catchment Council. Their main function is to regulate and supervise the exercise of rights to water within the area for which it was established**. Sub-Catchment Councils are comprised of water users, members of government departments with legal responsibilities in the management of natural resources, and private organizations that represent interests or otherwise have a direct stake in water management in the catchment. The Sub-Catchment Councils are elected from representatives of these water users.

[199] Barefoot Education for Afrika Trust (BEAT). FAO. 2014. Capacity Assessment of the Food and Nutrition Council (FNC) of Zimbabwe.
[200] FNC. 2017. Food and Nutrition Council. GoZ. Available on: http://www.fnc.org.zw/ (Accessed 18 July 2016)

Catchment and Sub-Catchment Councils are centrally funded through the Water Fund, established in the ZINWA Act (1998). However, funding has been limited for both councils. Despite funding challenges, they have continued to operate: producing 'catchment outline plans' that guide water development and management and holding elective and ordinary meetings in line with the legal provisions.

#### *2.2.3.2 Irrigation institutional arrangements*

The **Ministry of Agriculture, Mechanisation, and Irrigation Development** (MLAWCCR) has overall responsibility for development and implementation of irrigation policy and services. Responsibility for various aspects of irrigation services is shared among units within MLAWCCR, as follows:

- **AGRITEX** (see above) – responsible for providing extension services to all farmers, including irrigators, and its research section is responsible for conducting soil surveys and testing for irrigation development
- **Agricultural and Rural Development Authority (ARDA)** – a parastatal agency responsible for the operation of government-owned, irrigated estates and farms. It works closely with the Department of Irrigation
- **Department of Irrigation (DOI)** – mandated with responsibility for all irrigation activities in the country, including planning, identification of schemes, design and construction of new schemes and operation and management of existing schemes. DoI's focus is on disbursing funding in GoZ's Public Sector Investment Programme (PSIP), which is aimed at reviving irrigation infrastructure to help increase food security in rural households (see Chapter 3)
- **Grain Marketing Board (GMB)** – a parastatal agency in charge of marketing the country's strategic grains. All controlled crops such as maize and wheat from irrigation schemes are expected to be sold to the GMB at regulated prices. The GMB is also supposed to administer the government input credit scheme for irrigators

### *2.2.4 Faith and Community-based Organisations*

In the rural set up, a number of Faith and Community-based Organisations (FCBOs) operate, and these can be placed into two categories. The first is **social-based groups** formed by communities to address issues of concern faced by members. The most common ones are savings clubs and burial societies. Saving clubs can be classified on gender and church lines. For example, there are women-only saving clubs. The second is **state-introduced CBOs**, usually formed to service a particular intervention, such as irrigation or agricultural value chain development. Regarding irrigation, **Irrigation Management Committees (IMC)** are formed on every irrigation scheme. Their role is to oversee management of the scheme. They often have a constitution and by-laws, which govern how schemes are run, and sub-committees responsible for specific tasks, which may include a Maintenance Committee, Water Committee, and Marketing Committee. They are invited to sit in Catchment Councils and work closely with AGRITEX Officers who are attached to every scheme. **Farmers associations** are also formed, with the aim of collectively organising farmers to capitalise on economies of scale and increase their negotiating power.

These informal, local level groups are not fully functional for a number of reasons, including lack of coordination with national, sub-national and local level institutional structures and limited capacity to establish effective management and governance arrangements (see Chapter 4). Often, when established by NGOs and AGRITEX for specific purposes, they do not last beyond the purpose for which they were formed. IMCs in particular suffer from various challenges, including limited capacity to operate irrigation infrastructure, such as fixing common problems such as leaking pipes and faulty values, which increase water loss[201]. As their sustainability relies on monthly contributions from individual members (collected in the Maintenance Fund), poor management and governance arrangements often lead to a lack of resources to bring in external support to fix breakages. Tensions within IMC memberships over pumping schedules, due to the nature of common operation despite individual cropping preferences, and other issues, have in some instances resulted in them being disbanded.

The Zimbabwe Farmers' Union (ZFU) is the largest farmers' interest organisation in the country[202]. It represents over a million farming households and has representative councils on district and provincial levels, which members from local farmer organisations and clubs feed into[203]. It has sub-wings consisting of women, youths

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[201] Moyo, M. *et al.* 2017. Irrigation development in Zimbabwe: understanding productivity barriers and opportunities at Mkoba and Silalatshani irrigation schemes. International Journal of Water Resources Development. 33(5), pp.740-745.
[202] ZFU. 2017. Zimbabwe Farmers Union: About Us. Available on: http://www.zfu.org.zw/about-us (Accessed 5 May 2017)
[203] Ibid.

and commodity associations[204]. While ZFU structures are often not accessible for the majority of the poorest and most vulnerable rural smallholders, ZFU is an important farming institution and a platform that holds potential to influence agricultural policy.

### *2.2.5 The private sector*

As is the case for the 'private sector' in all contexts, it is by no means a homogenous entity. There is a variety of diverse actors in the private agriculture sector in Zimbabwe, providing a multitude of services to farmers ranging from input supply, food processing, outgrower schemes and agro-dealers. The private agriculture sector is relatively strong, although it has seen significant shrinkage and fragmentation in recent years[205]. The main broad categories of different private sector actors are outlined below.

*Seed producers:* The seed sub-sector is strong. Zimbabwe has three major seed companies: SeedCo, Pioneer and Pannar, conducting crop breeding programmes, including producing seeds that can withstand climate variability impacts such as increasing and intensifying droughts and more intense heat. The companies provide seeds such as maize, sorghum, soya bean, wheat etc. and have distribution networks that reach the major urban areas. The gap between the company depot in urban areas and local farmers is often filled by agro-dealers, usually locals with a shop in a growth point who take risks carrying stock, as their demand is not predictable. There are also smaller private companies who service the seed sub-sector, such as micro finance institutions and insurance companies including Ecobank Zimbabwe Ltd., CBZ Bank Ltd., Steward Bank Ltd., and Old Mutual Insurance Company (Pvt) Ltd. Public institutions also have crop breeding programmes, such as the Crop Breeding Institute of DRSS.

*Food processing:* The food processing industry, which was previously very strong, has shrunk over recent years. While there are approximately 130 formal agro-processing companies that manufacture food and beverage products (the number is likely to be much higher due to informal agro-processors that exist in rural areas), they are operating at significant under-capacity, due to a lack of reliable supply[206]. The industry also faces competition from cheap imports from South Africa. While informal agro-processors are not 'companies' per se, they are an important part of the processing landscape overall, especially in relation to rural agricultural livelihoods[207]. Informal agro-processors operate to supply local communities, whereas formal agro-processors focus on domestic retail markets and potential export markets[208]. Additionally, many individual subsistence farmers do some degree of processing or pre-processing of their own household foods[209].

*Out-grower schemes*: In order to secure agricultural produce, there are companies that, in addition to their own production, offer smallholders the opportunity to grow the same crop under a contract arrangement. Usually out-grower schemes work well for a crop that cannot easily be side-marketed. Examples include Matanuska for bananas, Cairns for tomatoes and beans, Schweppes and CESVI for citrus fruits and Heifer International for livestock in Chiredzi.

*Water and irrigation*: There are many small sized companies (with highly skilled personnel) dealing in irrigation design and construction. To give a sense of the size, according to the Zimbabwe Business Directory, there are 54 companies whose names contain or are associated with 'irrigation'[210]. Some of these include: Harare Pumps and Irrigation, Drip Tech, Greencon, Waterwright Irrigation (Pvt) Ltd and Centre Pivot Irrigation (Pvt) Ltd. Some of these companies also provide options for solar pumps, which is a recent development in the country. The number of solar companies is estimated at 16[211]**.** Some of these include: African Energy, Clamore Solar/Clamore Power, PowerOn Solar Pvt Ltd, Samansco and Solar Express. These companies are contracted by government departments and donor agencies. In addition to these companies are independent consultants/sole traders who offer consultancy services.

*Middlemen:* For farmers who cannot afford to transport produce to the market, middlemen provide what may be the only service to most remotely located rural smallholder farmers: middlemen buy produce at the farmgate. However, the farmgate price is often much lower than the market.

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204 Ibid.
205 Technoserve. 2016. Zimbabwe Agro-Processing Sector. Researching & Developing Strategies to Improve Food Security & Economic Development in Zimbabwe. Full Research Paper – with Recommended Models and Strategies. Technoserve.
206 Ibid.
207 Ibid.
208 Ibid.
209 Ibid.
210 Zimbabwe Business Directory: Irrigation index. Available on: http://thedirectory.co.zw/listings.cfm?searchfield=Irrigation (Accessed 18 June 2016).
211 Zimbabwe Business Directory: Solar Energy Wholesale Suppliers in Zimbabwe. Available on: http://energy.sourceguides.com/businesses/byGeo/byC/Zimbabwe/byP/solar/byB/wholesale/supplier.shtml (Accessed 18 June 2016).

### 2.2.6 Research organizations and universities

The **International Centre for Tropical Agriculture (CIAT)**, part of the Consultative Group on International Agricultural Research (CGIAR), undertakes research and development activities that aim to increase rural communities' food and nutrition benefits, support smallholder agriculture commercialisation, and build communities' resilience to climate change[212]. Activities in Zimbabwe include upscaling of bean production through community-based seed production, climate resilient agriculture practices, market linkages, and promotion of nutrient-dense bean production in collaboration with FNC, AGRITEX and DR&SS.

**The International Crops Research Institute for the Semi-Arid Tropics (ICRISAT)**, also part of CGIAR, conducts agricultural research for development in the drylands of Asia and sub-Saharan Africa. Housed in the Matobo DR&SS research station, ICRISAT is promoting various climate resilient agriculture activities, including drought tolerant small grains production and improvement of livelihoods in semi-arid areas through increased crop-livestock interactions, such as the production of goats and fodder. Fodder crops can sustain animals in the dry season and contribute to better milk production, better meat quality and increased household income. ICRISAT is implementing the Small Grain Improvement Programme, which has been running for many years, and is involved climate scenario planning, working closely with DRSS and AGRITEX (see Chapter 3). Also, ICRISAT is a partner to the ZRBF ECRAS consortium.

**The International Maize and Wheat Improvement Centre/ Centro Internacional de Mejoramiento Maiz y Trigo (CIMMYT)**, also part of CGIAR, works to improve livelihoods by fostering more productive, sustainable maize and wheat farming[213]. It is undertaking a number of breeding programmes and seeks to build and strengthen a new generation of national agricultural research and extension services in maize- and wheat-growing nations[214]. It is implementing IFAD's Smallholder Irrigation Revitalisation Programme, which started earlier in 2017 (see Chapter 3).

**The World Agroforestry Centre** is working with DR&SS and AGRITEX to propagate *Faidherbia albida,* a tree species that fixes atmospheric nitrogen, for use in cropping systems[215]. It is expected that there will be benefits in improved soil fertility, yields and livestock production through enhancement of feed for livestock.

**Universities:** Zimbabwe has 18 **state and non-state universities** that are engaged in research on aspects of climate variability and change. Agriculture faculties in particular have conducted studies on rain fed cropping, water and irrigation development, and rangeland and livestock production systems, a number of which have been undertaken in southern Zimbabwe.

### 2.2.7 Non-governmental Organisations

There is a wide range of international and national NGOs present in Zimbabwe. The main actors relevant to climate change adaptation, food and water security and agriculture in southern Zimbabwe are listed below

**The Zimbabwe Resilience Building Fund** was established in 2015 under MLAWCCR and works through 7 consortia of NGO's, private sector and research institutions, all led by INGO's. ZRBF is implemented with support from DFID, SIDA, EU and UNDP. 3 of the consortia are present in the districts of Southern Zimbabwe targeted by this funding proposal[216]. The ECRAS consortium is led by CARE, the Sizimele consortium is led by DanChurchAid and the Progress Consortium by International Rescue Committee. All consortia focus on supporting communities to build resilience to current climate risks as well as socio-economic shocks and stressors.

**Cesvi** – an Italian NGO – has been working in Zimbabwe since 1998 with a main target of combining environmental conservation of protected areas and protection of endangered species with the socio-economic development of the poorest communities[217]. Recently, Cesvi implemented the Shashe Citrus Orchard project, which allows for the cultivation of 22,000 oranges on over 90ha of communal land and is part of the Progress Consortium under ZRBF.

**Practical Action** is a key implementer in Zimbabwe, working in food and water security, access to energy and reducing vulnerability to disasters, with a focus on addressing climate change and strengthening markets[218]. It is implementing projects in solar power for rural, small-scale irrigation schemes and climate information services.

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[212] CGIAR. 2017. Where we work. Available on: http://ciat.cgiar.org/where-we-work/africa/ (Accessed 5 May 2017)
[213] CIMMYT. 2017. About Us. Available on: http://www.cimmyt.org/ (Accessed 5 May 2017)
[214] CIMMIT. 2017. Our Work. Available on: http://www.cimmyt.org/our-work/ (Accessed 5 May 2017)
[215] World Agroforestry. 2017. About Us. Available on: http://www.worldagroforestry.org/ (Accessed 5 May 2017)
[216] http://www.zrbf.co.zw/projects
[217] CESVI. 2016. Country Case Study. Working to Zero Hunger. Zimbabwe. CESVI.

**Oxfam** – an international NGO (INGO) – focuses on securing livelihoods, empowerment, gender justice and humanitarian response in Zimbabwe[219]. It has implemented the Coping with Drought project (2008-2012) and the UNDP/GEF funded Scaling up Climate Change Adaptation Project (2014-2018) in partnership with the Plan International, Southern Alliance for Indigenous Resources (Safire), MSD, University of Zimbabwe and AGRITEX, which focuses on climate smart and resilience building interventions in communities in southern Zimbabwe.

**SNV Zimbabwe** is engaged in projects that provide market-based, sustainable solutions in agriculture, energy, water, and sanitation and hygiene, paying particular attention to gender equity, opportunities for youth and climate change[220]. It has implemented a number of projects focused on value chain strengthening and marketing in the southern provinces.

**Technoserve** – an INGO – is operating in Zimbabwe to strengthen the agriculture industry by assisting agricultural businesses[221]. It has recently implemented DFID's Agro Initiative Zimbabwe[222].

### *2.2.8 International organizations – intergovernmental organizations*

**The United Nations Development Programme,** UNDP, is working to support communities to build resilience with a focus on climate change. It implemented the Coping with Drought project together with Oxfam (see above), and is now implementing its successor, the GEF/UNDP funded Scaling Up Adaptation, with OXFAM working closely with the MLAWCRR. Also, the Zimbabwe Resilience Building Fund under MLAWCCR is implemented with support from UNDP.

**The Food and Agriculture Organization**, FAO, works in Zimbabwe with a focus in three priority areas: Strengthening agricultural policy frameworks; sustainable agricultural productivity and competitiveness; and disaster risk reduction and management to improve the resilience of communities to disasters[223]. FAO has implemented multiple smallholder irrigation programmes in recent years, working closely with MLAWCCR, and is currently implementing the Food and Nutrition Security component of the Livelihoods and Food Security Project (see Chapter 3).

**The International Fund for Agricultural Development** (IFAD), a specialized agency of the United Nations mainly works with irrigation development in arid areas in Zimbabwe. In January 2006, IFAD's financial support to all operations in Zimbabwe ceased as a result of non-payment of arrears, but the fund has recently resumed its operations in Zimbabwe through its Smallholder Irrigation Revitalisation Programme (see chapter 3).

**The World Food Programme** (WFP) in Zimbabwe works to support food insecure rural households in achieving food security and building resilience to climate and non climate related shocks and stressors. In order to achieve this, WFP provides cash or food to meet families' short-term needs, while assets such as water harvesting systems – are rehabilitated or created for long-term food security. The WFP also focuses on aspects of marketing and is introducing the R4 Rural Resilience initiative in Zimbabwe, which includes climate related insurance and risk reduction initiatives.

**The World Bank's** (WB) lending program in Zimbabwe in inactive due to arrears and its role is now limited to technical assistance and analytical work through Trust Funds. Part of the technical assistance is focused on climate change response and channelled through the Zimbabwe Reconstruction Fund, and through the Climate Change Technical Assistance Program (ZIM-CLIM). Key areas for ZIM-CLIM investments include scaled up climate resilient irrigation and water management infrastructure, enhanced landscape management and strengthened climate services, with support mainly provided through studies and support to develop strategies and approaches to address climate change issues.

### *2.2.9 Donors*

**The Swedish Development Cooperation**, SIDA, in Zimbabwe has made investments into resilience building of vulnerable groups to shocks and stressors, incl. climate change impacts. Most of the Swedish aid to Zimbabwe is channelled through multilateral channels or directly to civil society organizations. Since 2016, Sweden is one of the donors to the Zimbabwe Resilience Building Fund.

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[219] OXFAM. 2017. Zimbabwe. Available on: https://www.oxfam.org/en/countries/zimbabwe (Accessed 5 May 2017)
[220] SNV. 2017. Zimbabwe. Available on: http://www.snv.org/country/zimbabwe (Accessed 5 May 2017)
[221] Technoserve. 2017. Where we work: Zimbabwe. Available on: http://www.technoserve.org/our-work/where-we-work/country/zimbabwe (Accessed 5 May 2017)
[222] Technoserve. 2016. Zimbabwe Argo-Processing Sector. Researching & Developing Strategies to Improve Food Security & Economic Development in Zimbabwe. Full Research Paper – with Recommended Models and Strategies. Technoserve.
[223] FAO. 2017. Country Profiles: Zimbabwe. Available on: http://www.fao.org/countryprofiles/index/en/?iso3=ZWE (Accessed 5 May 2017)

**The Department for International Development of the UK,** DFID, is active in Zimbabwe on a number of issues related to building resilience of vulnerable rural communities to climate change impacts. DFID is one of the donors to the Zimbabwe Resilience Building Fund and also funds the Zimbabwe Livelihoods and Food Security programme as well as the regional initiative on climate resilient agriculture, VUNA.

**The Delegation of the European Union to the Republic of Zimbabwe,** EU, works through its National Indicative Programme for Zimbabwe 2014-20 with a focus on 3 main sectors: health, Agriculture based economic development and governance and institution building. As part of the focus on Agriculture based development, EU supports the Zimbabwe Resilience Building Fund as well as other initiatives to strengthen agricultural resilience and sustainable natural resources management.

**The Japan International Cooperation Agency,** JICA supports Zimbabwe on Agricultural Development through small scale rehabilitation of irrigation schemes and technical assistance. JICA is now introducing a new Small Holder Empowerment Program in Zimbabwe with the aim to strengthen market linkages for smallholder farmers.

**The Swiss Agency for Development Cooperation,** SDC has a focus on improving food security in the SADC region by supporting improved seed production, improved post harvest management and early warning systems/ disaster risk reduction.

# 3 Past and on-going interventions to improve rural, agricultural livelihoods : Building on existing efforts

This chapter presents an overview of the key past and on-going interventions (climate and non-climate) implemented by GoZ, donors, NGOs, civil society and private companies to improve rural smallholders' livelihoods. After presenting GoZ's focus areas and an overview of donor coordination in the agriculture space, the chapter is structured around the broad focus areas of interventions, namely: (i) water security; (ii) agricultural investments for livelihoods; (iii) value chain development; iv) climate information services and (v) institutional capacity building. Information was collected primarily through sub assessments supporting this feasibility study, further desk-based review and corroborated by consultations with stakeholders.

## 3.1 GoZ investments

GoZ prioritises investment in increasing smallholders' adaptive capacities to climate change, recognising the potential smallholders have to developing the agriculture sector and the wider economy. In previous decades, GoZ has prioritised irrigation development as a response to increasing water security for rural communities[224]. GoZ's Public Sector Investment Programme (PSIP) (2013-2017) focuses on developing irrigation infrastructure on communal lands in poor rainfall areas[225]. GoZ has also focused on developing the agricultural sector, spearheaded by GoZ's Zimbabwe Agriculture Investment Plan (2013-2018), guiding structural changes in policy and investment to ncrease production from a longer-term perspective (rather than focusing on reacting to climate and non-climate shocks that have crippled the sector)[226]. In recent years, GoZ has increasingly focused on mainstreaming climate change into developing planning, as evidenced by the NCCRS (2014) and the National Climate Policy (2017).

## 3.2 Donor coordination

There is a number of interventions working in Zimbabwe in the agriculture sector. Realising the need to build resilience of rural livelihoods to both current climate risks and socio-economic shocks and stressors, the Zimbabwe Resilience Building Fund (ZRBF), a multi-donor initiative, hosted in MLAWCCR and funded by DFID, EU and SIDA, was setup in 2015 to coordinate efforts in long-term resilience building in the country. To do this, ZRBF has mapped long-term resilience building efforts (see Figure 27). In addition to actors identified on the map, several local NGOs and CBOs operate in the areas (many discussed in the sections below). This coordinated approach aims to encourage projects to intervene in a strategic, targeted and collaborative way – one that avoid overlaps, builds on synergies and complements other investments. In targeting its own interventions, ZRBF has deliberately chosen to focus on vulnerable districts with little presence from other large projects. As can be seen in Figure 21, there is good potential for building on and complementing resilience building efforts and market linkages as promoted by ENSURE and AMALIMA, efforts in the livestock value chain, promoted by the Feed the Future Zimbabwe initiative on livestock development (FTFZ-LD), and complementarities with the ZRBF consortia in both geographic location and scope. A key task of the project will be to leverage on synergies with other development actors and expertise and build on existing baseline investments to ensure adaptation to current and future climate risks for the agricultural sector. For an overview of past and current projects related to building resilience to climate change, best practices and lessons learnt, see annexes 12-14.

Continuous stakeholder engagement with key actors in resilience building efforts listed in tables in annexes 12-14 has taken place throughout the development of the project idea and during the targeting exercise, to avoid overlaps, explore complementarities and facilitate synergies. Examples of consultations include coordination with IFAD and FAO on interventions related to the choice of irrigation schemes; coordination with WFP and WB on climate information needs assessment, systems and capacity building; coordination with USAID and ZRBF on complementarities with ongoing and future climate change adaptation and resilience building investments; and consultation with ZRBF on potentials for cooperation within a national resilience building framework (see stakeholder annex to full proposal).

[224] MLAWCCR. 2013. Public Sector Investment Programme (PSIP) (2013-2017). GoZ, Harare.
[225] Ibid.
[226] MLAWCCR. 2013. ZAIP (2013-2018). A Comprehensive Framework for the Development of Zimbabwe's Agriculture Sector. GoZ, Harare.

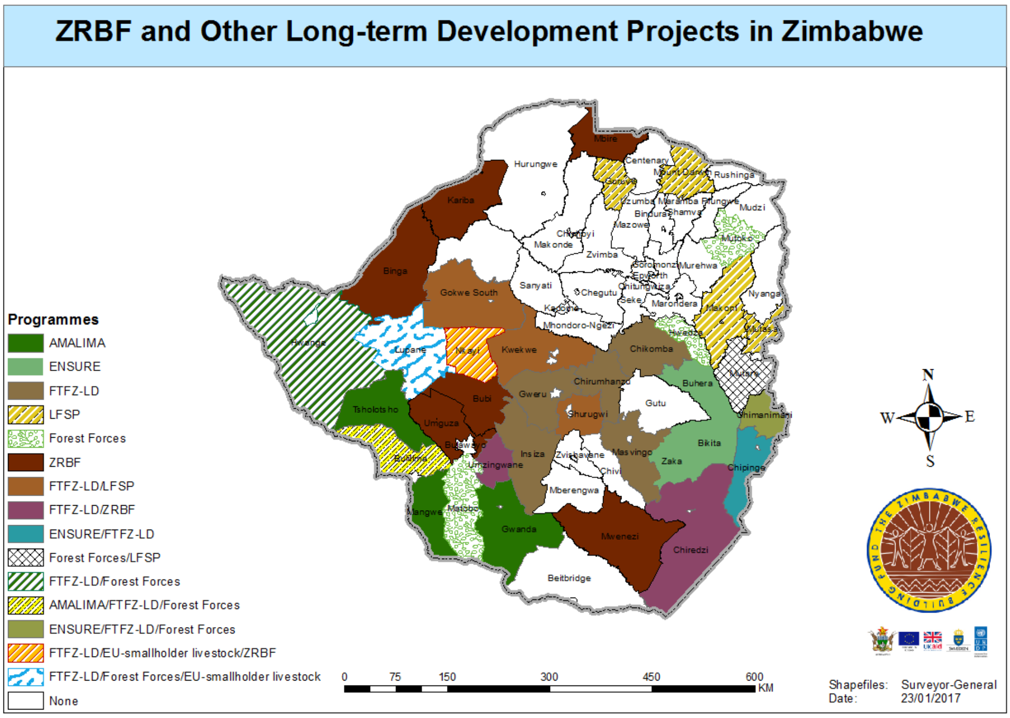


Figure 27: Projects working in long-term development and resilience building, as per January 2017

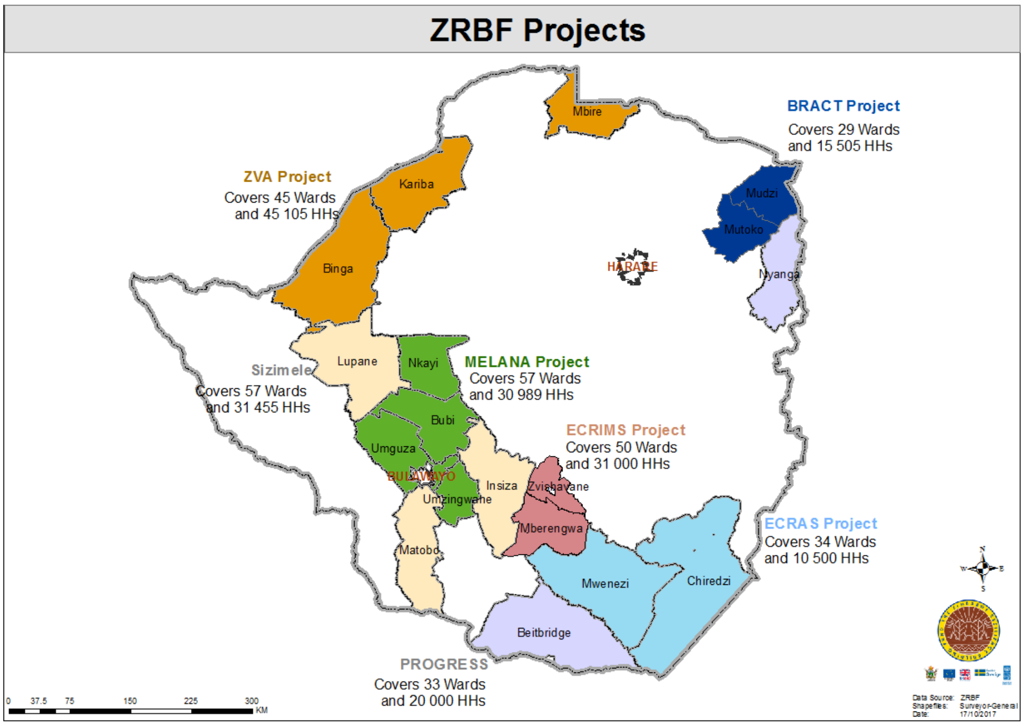


Figure 28: ZRBF projects contracted in 2016 and 2017, as per October 2017

### 3.3 Water security for agricultural livelihoods: small-scale, rural irrigation

In support of GoZ's PSIP investment, a series of programmes funded by donors such as the Swiss Agency for Development Cooperation (SDC), Brazil, European Union (EU), United Nations Food and Agriculture Organisation (FAO), International Fund for Agriculture Development (IFAD), and Japan International Cooperation Agency (JICA) are implementing irrigation schemes. Table 8 (below) presents the main interventions. Many have components that compliment irrigation development, such as linking smallholders in irrigation schemes to markets and increasing farmers' capacities in agronomy and scheme management. For example, **FAO**'s Smallholder Irrigation Support Project includes a component to increase irrigated farmers' crop production capacity and promote agribusiness development. There is potential for synergy and collaboration, as implementation is happening at the same time. Notably, **IFAD**'s Smallholder Irrigation Revitalisation Programme has started implementation, focusing on revitalising 5,000 ha of existing smallholder irrigation schemes, mostly in communal and old resettlement areas in AERs III, IV and V in Manicaland, Masvingo, Matabeleland South and Midlands provinces. It has a climate resilient agriculture and market access component, selecting suitable high value crops to be introduced at irrigation schemes, as well as support to institutional capacity. For an overview of irrigation interventions, see annex 12.

There have been only a few irrigation efforts that factor climate resilience considerations into design and implementation. For instance, DFID's CRIDF programme at its pilot sites in Kufandada (Bikita) and Bindagombe (Chivi) implements a climate resilient approach to irrigation development based on designs and tools that factor changes in land and water resources as a result climate change. The CRIDF model also includes installation of solar as a power source for irrigation, institutional capacity building (O&M), agronomy support and links to markets (see case study, below).

Adding to the complexity of water management, the river basins in the Southern provinces are transnational. The Save Basin, for instance, is one of three river basins that traverse the border between Mozambique and Zimbabwe. This cross-boundary location has presented challenges for water resource management and development. CRIDF presents a promising experience in transboundary water management, as it has created a space for learning and dialogue for the Mozambique and Zimbabwean Water authorities to build their capacity to improve local water management for transboundary benefits, climate change mitigation and adaptation and integrated water resource management. This is contributing to transboundary cooperation and promoting an Integrated Water Resource Management (IWRM) approach. Strengthening the relationship between Mozambican and Zimbabwean counterparts is a significant step towards further developing the basin for the benefit of its poorer inhabitants and creating climate change resilience. See annex 15 for more information.

### *3.3.1 Case study: CRIDF interventions in the Save River Basin*[227]

The Chivi and Bikita Districts lie within the Save river basin. Historically, communities have practiced rain fed agriculture, which posed a viable livelihood strategy without any serious challenges. Recent years, however, have seen increasing climate impacts, such as a lengthening dry season and longer mid-season dry spells. Unsustainable local land use, including streambed cultivation in search of sufficient soil moisture, has led to soil erosion and silt build-up in the river and its associated infrastructure, damaging the river ecosystem. Unemployment also tops 90 percent, and there is a high dependency on subsistence farming, which means the population is extremely vulnerable to drought, hunger and malnutrition, while relying on potentially diminishing and contaminated water sources.

CRIDF is supporting the Kufandada and Bindamombe communities to climate proof and improve their livelihoods through a combination of climate resilient water abstraction and storage infrastructure, the use of solar power, strengthened climate risk-informed institutional arrangements, agriculture extension services and support to (re)build profitable agri-businesses on schemes and in communities surrounding the schemes.

CRIDF has recently completed the **Kufandada irrigation scheme**, which focuses on reducing the growing climate vulnerability of the local community and Bikita Rural Hospital, by ensuring the availability of safe, clean water for domestic usage, as well as enabling farmers to boost their incomes by engaging in effective, small-scale, commercial farming. The Kufandada scheme design includes a 100kW solar power supply, a weir, 1 million litre night storage tank and several kilometres of pipe network for irrigation. Water is now channelled via solar power pumps to irrigate 28 hectares of land via sprinkler systems from a newly constructed weir. Solar power supply is set up to also directly benefit the hospital, with a total service population of approximately 40,000. The hospital has been assisted to revive its in-patient nutrition garden scheme.

A second, similar, water infrastructure scheme has been implemented at **Bindamombe**. This facilitates the irrigation of 34 hectares of farmland, enabling farmers to diversify their crops and grow year-round. Together with the provision of five new boreholes for village water collection, the scheme is set to improve the food security and nutritional status of 300 households with a further total of 1,200 households benefiting through employment opportunities.

Both projects combine the provision of climate resilient irrigation infrastructure with sustainable land use practices, CRA extension services and market linkages, including improving farmers' access to seed suppliers and links to agribusinesses for contract farming opportunities, to ensure the projects' value is maximized and lasting climate resilience is built for communities. To ensure the sustainability of the installed irrigation systems, farmers have been encouraged to no longer cultivate riverbanks and instead protect them with gabion mats and tree plantations, preventing soil erosion and consequential siltation of the downstream weir.

Table 9: Performance indicators of CRIDF projects in southern Zimbabwe[228].

| | Bindamombe | Kufandada |
|---|---|---|
| Climate | Annual rainfall of 450-650 mm, severe dry spells during the rainy season, and frequent seasonal droughts.<br>Considered unsuitable for dryland cropping. Smallholders grow drought-tolerant varieties of maize, sorghum, millet. | Annual rainfall of 500-750 mm, mid-season dry spells and high temperatures.<br>Production systems are based on drought-tolerant crops and semi-intensive livestock farming based on fodder crops. |
| Irrigation Development | 300 households are beneficiaries to the scheme.<br>Most beneficiaries are vulnerable to famine due to climatic conditions. | 120 households are beneficiaries including Bikita Hospital, which plants nutrition gardens with patients. The hospital serves 15,000 people per year, with a total service population of 40,000. |

[227] *Source: Irrigation Sub assessment, p. 53-65*
[228] *Source: Irrigation Sub assessment, p.55-56*

| | Bindamombe | Kufandada |
|---|---|---|
| | Beneficiaries elected an Irrigation Management Committee to steer development of the scheme. Beneficiaries adopted a constitution as well as rules and regulations for running the scheme. Beneficiaries have established a fund to finance operation and maintenance. Training on operations and maintenance carried out for beneficiaries.<br>Extension services to support climate resilient agriculture and sustainable land use.<br>Market linkages and production training to support farmers in increasing revenue. | |
| Installed infrastructure | 3.9 km of power line<br>2ML night storage reservoir to carter for power failures<br>34 Ha sprinkler irrigation system comprising of 300 plots of 0.1 Hectares each comprising of pumping plant and drag-hose sprinklers. System convertible to drip irrigation to cater for extreme events<br>Five hand pump boreholes<br>Environmental works to arrest land degradation and protect the fields | 100kW Solar power plant to provide a source of green energy and capable of powering the installation<br>A weir on the Rozva river designed to withstand a 1 in 100-year flood<br>28 Ha sprinkler irrigation system comprising of 120 plots of 0.2 hectares each, pumping plant, balancing 1ML reservoir and drag-hose sprinklers. System convertible to drip irrigation to cater for extreme events<br>Three hand pump boreholes<br>Environmental / erosion protection works to protect the works and weir from siltation |

## 3.4 Agricultural investments for livelihoods: increasing productivity in the face of climate change

Various government policies, strategies and other national documents identify the need to promote climate resilient agriculture in Zimbabwe. The efforts are largely guided by the ZAIP (2013-2018) and to some extent the NCCRS, the Zimbabwe Resilience Strategic Framework and CRA framework. A range of donors and non-governmental actors are complimenting GoZ's efforts in agriculture development. In recent years, the focus has shifted from intensification – increasing mechanised agricultural production, particularly on smallholder irrigation schemes – to promoting sustainable approaches, such as CRA.

The promotion of CRA in Zimbabwe builds on the definition of FAO (2010)[229] and the previous work to introduce Conservation Agriculture (CA) practices and interventions. In the context of AGRITEX, CRA is understood as a range of agricultural approaches that aim to achieve food security in a changing climate and develop agriculture in a sustainable way (Reference: Consultations with AGRITEX at national, provincial and district level). CA is understood as a no-till system that increases yields while protecting fields from erosion, improving soil quality and mitigating the effects of drought. The introduction of CA and CRA builds on a long history of conservation tillage promotion in Zimbabwe and CA has been promoted by GoZ to smallholders from the early 2000's as an alternative to traditional hand-hoe techniques[230]. In 2008, a CA taskforce was setup, chaired by MLAWCCR and FAO with the involvement of research institutions, NGOs and others[231][232]. Today, more than 300,000 Zimbabwean smallholders are practicing this method in part or wholly and have nearly tripled their production[233].

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[229] FAO. 2013. Climate-Smart Agriculture Sourcebook. FAO.

[230] FAO. 2013. Conservation agriculture contributes to Zimbabwe economic recovery. Available on: http://www.fao.org/in-action/conservation-agriculture-contributes-to-zimbabwe-economic-recovery/en/ (Accessed 5 May 2017)

[231] The National Conservation Agriculture Task Force has developed a CA manual with AGRITEX, which documents CA practices, tools and training tips for extension staff throughout the country to guide farmers in implementing CA. *Source:* Zimbabwe Conservation Agriculture Task Force. 2009. Farming for the Future: A Guide to Conservation Agriculture in Zimbabwe. Christian Aid and FAO Zimbabwe.

[232] FAO. 2013. Scaling up conservation agriculture I Zimbabwe. Available on: http://www.fao.org/news/story/it/item/178349/icode/ (Accessed 5 May 2017)

[233] According to FAO, CA was introduced through small-scale projects – with parcels of land where farmers practised the approach and were provided with inputs from development groups. The uptake was slow however as conventional methods continued to be used on surrounding plots. While farmers welcomed the inputs, they were not convinced enough to convert all of their land. FAO notes that the reason for this was that in its initial stages, conservation agriculture is more labour-intensive than conventional methods. However, the experiences with conservation farming are that once farmers pass the initial labour intensive, start-up seasons, their conservation agriculture techniques cut down on waste of inputs, reduce their costs and improved the yields significantly. FAO has since promoted the conservation agriculture methods through programmes of training and demonstrations, and introduction of labour saving mechanical planters to win over farmers. FAO reports that as a result more farmers adhered to the techniques and farmers, who have seen gains on their neighbours' farms have made the decision to adopt conservation agriculture. *Source:* FAO. 2013. Conservation agriculture contributes to Zimbabwe economic recovery. Available on: http://www.fao.org/in-action/conservation-agriculture-contributes-to-zimbabwe-economic-recovery/en/ (Accessed 5 May 2017)

While CA is widely practiced, **the concept of CRA is relatively new and not widely understood by all governmental and non-governmental service providers.** However, there is commitment to promote CRA at every level from government, research and development institutes, NGOs, CBOs and farmer organizations. Many agriculture interventions already include elements of CRA promotion, involving thousands of vulnerable households. A strategic policy framework to promote CRA has been developed by MLAWCCR and other stakeholders and a current update on the agricultural extension policy has taken into account resilience, based on the work of the ZRBF. Also, realising the need to provide CRA training to current and future agriculture extension, workers and students of agriculture, the MLAWCCR, the Green Impact Trust, Zimbabwe and Climate Technology Centre and Network have developed a CRA Manual for Zimbabwe, which however lacks funding for roll out to agricultural colleges across the country. The country's Low Emission Development Strategy has analysed the potential for GHG emission mitigation in the agriculture sector and points to conservation agriculture as having significant mitigation benefits, while also being an effective adaptation practice[234].

Many projects are implementing components of CRA, but **few projects are designed specifically to implement CRA**. Vuna, DFID's East and Southern Africa Climate resilient agriculture Programme, working in Zimbabwe as one of its target countries, explored CRA adoption mechanisms, including improved access to seed of modern, drought-tolerant, open-pollinated crop varieties, weather index insurance products, and agribusinesses engagement[235]. The consortia supported under ZRBF have a strong focus on promoting resilience, understood as improving the vulnerable group's capacities to adapt to and bounce back from the effects of shocks and hazards – both climate and non-climate related[236]. This includes a strong focus on climate risks and resilience building through CRA in combination with disaster risk management, weather information, market linkages and engagement of district level stakeholders to improve service delivery. Other long-term projects such as the USAID funded programmes: ENSURE, Feed The Future, AMALIMA, and the DFID funded Livelihoods and Food Security Project, also focus on promoting CRA practices to smallholders. Other key projects that implement CRA techniques include the UNDP/GEF Scaling Up Adaptation project, which promotes a variety of CA/CRA crops and practices along with water harvesting and conservation techniques, including infield water harvesting, infiltration pits, contour ridges, mulching. The most common soil and water conservation practices are infield rainwater harvesting and mulching, introduced to increase farmers' water efficiency and to cushion crops against the impacts of droughts and dry spells[237,238].

Research institutions such as **CIMMYT** and **ICRISAT** have long been engaged in Zimbabwe and are working to promote CRA practices in collaboration with DR&SS and AGRITEX – and through ZRBF consortia. ICRISAT, for instance, has promoted drought resilient small grains production, as well as sustainable crop-livestock interactions through a number of climate resilient initiatives, including i) addressing challenges in rangelands management and fodder production to get livestock through the dry season, ii) matching livestock breeds to the prevailing ecological environment, for example by promoting small livestock such as goats and sheep or producing cattle hybrids that could withstand harsh climatic conditions in semi-arid regions, and iii) promoting alternative livestock feeds through crop-livestock interactions and promoting of bana grass and mucuna shrubs, which do well in both high and low rainfall areas. ICRISAT has also been involved in promoting soil-water conservation and rain-water harvesting techniques with World Vision International (WVI) in Gwanda, Insiza and Beitbridge districts. The Intermediate Technology Development Group is also promoting the use of soil-water conservation and rain-water harvesting[239].

An innovative development from ICRISAT and CIMMYT, in partnership with AGRITEX and DRSS is the introduction of **Innovation Platforms**. The Innovation Platform approach grew out of the private sector as a means of gathering information and improving networking among key stakeholders in a particular economic sector, but has since caught the attention of development agencies and is now gaining popularity in research and

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[234] The mitigation benefits of applying CA are estimated at 11.63 MtCo2eq by 2030. This is estimated based on national plans and projections for CA and is not specific to the Southern part of Zimbabwe. Low Emission Development Strategy, 2019.
[235] Vuna Africa. 2017. Vuna Africa. Changing farming, for a changing climate. Available on: http://vuna-africa.com/ (Accessed 5 May 2017)
[236] The definition of Resilience agreed for Zimbabwe is "*the ability of at risk individuals, households, communities and systems to anticipate, cushion, adapt, bounce back better and move on from the effects of shocks and hazards in a manner that protects livelihoods and recovery gains, and supports sustainable transformation*." (Building Resilience in Zimbabwe: towards a resilience strategic framework, March 2015.)
[237] Zimbabwe Conservation Agriculture Task Force. 2009. Farming for the Future: A Guide to Conservation Agriculture in Zimbabwe. Christian Aid and FAO Zimbabwe.
[238] Mupangwa, W and Twomlow, S J and Walker, S. 2012. Dead level contours and infiltration pits for risk mitigation in smallholder cropping systems of southern Zimbabwe. Physics and Chemistry of the Earth, Parts A/B/C, 47-48. pp. 166-172. ISSN 1474-7065
[239] ITDG. 2006. Soil–water conservation and rainwater harvesting strategies in the semi-arid Mzingwane Catchment, Limpopo Basin, Zimbabwe. Available on: https://www.researchgate.net/publication/222940183_Soil-water_conservation_and_rainwater_harvesting_strategies_in_the_semi-arid_Mzingwane_Catchment_Limpopo_Basin_Zimbabwe (Accessed 15 July 2017).

development initiatives[240,241]. In Zimbabwe, Innovation Platforms have mainly been used as a tool to develop agricultural value chains by identifying challenges and solutions in collaboration with a wide range of stakeholders across the agricultural value chain in question[242]. For an overview of past and current projects with components on building resilience to climate change and promoting CRA, see annexes 12-14

### 3.5 Smallholder commercialisation: strengthening value chains, linking farmers to markets and access to finance

A series of donors, including FAO, UNDP, USAID and DFID, have supported GoZ's investments in value chain development, with implementation support from local partners, such as SNV, Technoserve, SAFIRE and CESVI. In addition, various ZRBF consortia are investing in value chain development of various crops (sesame, small grains and horticulture) and livestock value chains.

Efforts have predominantly focused on linking smallholders to markets through **contract farming arrangements** and providing '**business enterprise' skills** to farmers. For example, **USAID's Amalima** project is providing training to over 56,000 households in Tsholotsho, Bulilima, Gwanda and Mangwe districts for vulnerable communities to engage in value chains. A particular focus is on women and providing technical training to agrodealers to improve the availability of and access to quality agro and veterinary inputs to farmers. **USAID's Ensure** project also focuses on building the capacity of farmers to engage in value chains, focusing on the groundnut, small livestock and horticultural crops value chains, by supporting Farmer Field Schools, producer associations, agro-dealers and other actors in the value chains.

There have only been a few efforts that target the *climate resilient* commercialization of farmers. **ZRBF interventions** have largely been based on an analysis of climate and non-climate risks and hazards. For example, initiatives under ZRBF include the Enhancing Community Resilience and Sustainability (ECRAS) consortium led by CARE International and the Matabeleland Enhanced Livelihoods, Agriculture and Nutrition Adaptation (MELANA) led by Welthungerhilfe. ECRAS and MELANA are focusing on supporting sesame value chains, based on an analysis of potentials for climate resilient crop production. **Vuna, DFID**'s East and Southern Africa Climate resilient agriculture programme is working in the goat value chain in the south of the country. In two districts in Matabeleland province, Vuna has provided a grant to SNV and a private company (WholeBeef) to support communal farmers to improve their goat husbandry through CRA and links to the company. Another is the **UNDP**/GEF project **Scaling up Adaptation** (2014-2018), which has reached almost 10,000 households through adaptive investments, market linkages and financial access across the districts of Buhera, Chiredzi and Chimanimani. The project has successfully supported market linkages and developed short value chains, such as honey, beans, tomatoes, small grains, goats, cattle and indigenous chicken that support adaptation to climate change[243]. The value chain development has resulted in improved and sustained incomes for farmers through agricultural seasons with below normal rainfall – in comparison to other farmers in the same districts[244]. The project has had a special focus on women farmers and has developed and scaled up pro-women value chains that support adaptation to climate variability and change. This includes the honey and goat value chains. The project also established inclusive financial services to support climate risk management, livelihood diversification and other adaptation investments.

Regarding the **livestock value chain**, there have been specific efforts to increase livestock production and value addition. ICRISAT has led multi-stakeholder efforts on developing the goat value chain in Insiza, Matobo and Gwanda, Matabeleland South through Innovation Platforms. As part of this initiative, livestock handling facilities and marketing structures were upgraded, smallholders gained entry into formal value chains and trust and linkages among value chain stakeholders was built. Additionally, **USAID's Feed the Future – Zimbabwe Livestock Development** project trains farmers on good business practices, such as creating a budget that includes marketing activities, identifying lucrative markets within their reach, organizing themselves into groups, and negotiating with buyers for better prices. Farmers are learning essential animal husbandry practices, such as cattle pen fattening; animal health, nutrition, and breeding; cattle and meat grading; and strategic selling. The project is connecting farmers directly with abattoirs (slaughterhouses). Project activities target smallholder farmers in AERs III, IV, and V in the provinces of Manicaland, Midlands, Matabeleland North and South.

An important actor in smallholder commercialisation and strengthening value chains is **private companies in the agro-business sector**. Increasingly in Zimbabwe, private companies are seen to be entering into contract farming

[240] Homann-Kee Tui, S., Van Rooyen, A. F., and Minde, I. 2013. *National and Regional Livestock Markets: Opportunities for Growth in SADC.* Documentation. International Crops Research Institute for the Semi-Arid Tropics, Patancheru, Andhra Pradesh, India.
[241] Van Rooyen, A. and S. Homann. Innovation Platforms: A new approach for market development and technology uptake in southern Africa. ICRISAT.
[242] ICRISAT. 2013. Seven lessons learned to catalyse African innovation through engagement platforms. CGIAR.
[243] UNDP/GEF Scaling Up Adaptation with a focus on rural livelihoods, Terminal Evaluation, 2019
[244] UNDP/GEF Scaling Up Adaptation with a focus on rural livelihoods, Terminal Evaluation ,2019 – ZIMVAC data

arrangements with smallholders, incentivised by wishing to increase production and reliability of their supply chains. Such companies include Best Fruit Processing, Sidella, IETC, Matanuska, Schweppes, Cairns, AgriSeeds and Zimbabwe Super Seeds. These arrangements can provide farmers with agro-inputs, access to training, and links to the formal domestic market.

**Research centres** also play an important role in developing climate resilient value chains, particularly in the production of more 'drought tolerant' seeds and livestock varieties. For example, the **International Centre for Research on Maize and Wheat (CIMMYT)** has collaborated on drought tolerant maize seed research with DR&SS's Crop Breeding Institute (CBI) and private sector partners such as Progene, AgriSeeds, SeedCo and Pannar. Similarly, **ICRISAT**, in collaboration with NGOs who facilitate pilot testing, in particular the Community Technology Development Trust, has invested in small grains variety research in the dry areas.

Increasing smallholders' **access to finance** has been the focus of a number of interventions in the last decade. Financial services are crucial to rural livelihoods and the development of the rural economy, as they allow farmers to save capital and invest in agro-inputs to increase production[245]. Informal financial services are common in rural settings, such as Funeral Societies, Savings and Lending groups, and informal lending between families. The majority of efforts, such as those by Care, UNDP, TechnoServe, OXFAM, DFID, FAO, USAID and World Vision, have focused on supporting **Village Savings and Loan Association** (VSLAs). VSLAs, developed by Care International in Maradi, Niger in 1991, is an approach to facilitate savings and credit in a flexible way, appropriate to the informal setting[246]. Members of the community form a group, which converts small amounts of cash into savings. The group's savings can be lent to members as credit[247]. In Zimbabwe, VSLAs are usually women groups who mobilize funds from their own savings and use the pool of funds to meet their borrowing and insurance requirements. The savings are an asset, and reduce livelihood risk. They serve as a mechanism for transitioning out of safety net programmes or for building resilience in times of emergencies or shocks[248]. With DFID funding, FAO is supporting financial and microfinance institutions in introducing, designing and scaling up financial services to smallholders, including women and youth. In collaboration with DCA/ USAID, FAO has also designed the Refinance and Partial Guarantee facility, which are two instruments aimed at increasing financial inclusion of smallholders and value chain actors. In combination with market linkages and value chain development activities, UNDP's Scaling up Adaptation project has increased the income of 61.2% of the targeted VSLA farmers by an average of 35.7% from savings and interest accrued on average across the three target districts of the project. For an overview of past and current projects with components on building resilience to climate change in value chains and promoting market linkages, see annexes 12-14

## 3.6 Climate information services

In the past, donor efforts, primarily by UNDP and GEF, have supported government interventions in climate information. Annex 14 presents a summary of these projects, implemented mainly by NGOs, the key actors being Practical Action and OXFAM, in conjunction with MSD and AGRITEX. Most recently, the Green Climate Fund has approved a funding proposal for Zimbabwe with climate information components with WFP as accredited entity. Projects appear to address three main aspects relating to climate information, namely: a) **providing climate information infrastructure** in the form of weather stations; b) **building capacity of extension personnel and farmers** to understand climate information, and; c) **packaging climate information** so that it is easily useable by farmers (which includes exploring the use of software as well as the development of different approaches to seasonal forecasts).

The Coping with Drought project successfully developed a new seasonal forecast approach, which was shown to be more useful for agricultural decision making. This work has been scaled up and developed further through the project Scaling Up Adaptation. In partnership with MSD, AGRITEX and young innovators from local universities, the project has rolled out Climate User Interface Platforms to involve smallholder farmers in co-designing, co-producing and using tailored climate products. This has resulted in the piloting of a climate information delivery system appropriate to smallholder farmers and the translation of climate products into actionable advisories and early warnings. Practical Action, through the project Mainstreaming Climate Change Adaptation in Zimbabwe's Agricultural Extension System demonstrated the value of training AGRITEX workers in climate change adaptation and interpretation of weather information as a means of scaling out knowledge of adaptation strategies and training to farmers. For an overview of projects, best practices and lessons learnt, see annex 14.

[245] Inclusive Finance and Risk Insurance Sub-assessment.
[246] World Vision. 2015. Saving Groups. World Vision Guidance for Development Programmes. WV.
[247] Ibid.
[248] Ibid.

In addition, the private sector provides climate information services as well as crop insurance. ZimNat has been providing weather index insurance (WII) to farmers for the last 3 years. The WII product is called Pundutso and is available for the 2016-2017 season. The product is the result of 3 years of trialling and research into other models that have been successfully used in Africa.. A summary of the cover, the triggers and summaries of the triggers and rates are provided in Annex 16.  Econet Wireless provides a micro-insurance service ,Ecofarmer, designed to insure inputs and crop against drought or excessive rainfall, which includes daily weather information, crop data, farming tips, farming information and market links. Similarly, OXFAM has collaborated with Old Mutual and Blue Marble Micro Insurance on developing a micro WII service for vulnerable smallholder farmers linked to the Scaling Up Adaptation with a focus on rural livelihoods project.

Most recently, the WFP has supported Government of Zimbabwe to access funding from the Green Climate Fund to support climate information services and resilience building efforts in two districts, Masvingo and Rushinga.

## 3.7 Institutional coordination and capacity building

There have been several interventions in recent years to support GoZ institutional coordination and capacity building efforts in the water, agriculture and climate change sectors. **These have primarily focused on developing resources to strengthen service delivery**, mainly in departments under MLAWCCR: AGRITEX, DoI, DR&SS and the Livestock Department and MSD. While larger development programmes have supported coordination and capacity building at the national level (discussed here), many donor and NGO projects targeting vulnerable smallholders have also invested in building the capacity of subnational and community level institutions (some of which are discussed in pervious sections).

Since 2012, MLAWCCR has collaborated with the UNDP to mainstream climate change issues across government planning, through a number of projects. The first project, Strengthening National Capacity for Climate Change in Zimbabwe project (2012-2016), supported initiation of the National Climate Change Response Strategy (2014) and the National Climate Policy (2017). It also supported establishment of the Department of Climate Change Management Department, providing capacity building for staff to support the design of climate change mitigation and adaptation activities and pilot projects for scale up. The Supporting Enhanced Climate Action for Low Carbon and Climate Resilient Development Pathway (2016-2020) project aims to continue such efforts, e.g. by supporting the National Adaptation Process (NAP) and the development of the Forestry and the Renewable Energy Policy. The Support to Implmenting Zimbabwes NDC under the Paris Agreement has supported the development of a Low Emission Development Strategy, which includes the AFOLU sector. Through the GEF funded Scaling up Adaptation project, UNDP and the implementing partner, OXFAM, has supported MSD in weather and climate information services delivery as well as resilience building activities such as wetlands management, gulley reclamation, reforestation and holistic land management[249]. These interventions have been complemented by other capacity development support from development partners, including in the development of the CRA manual (see section 3.4).

MLAWCCR has been extensively supported by various partners to enhance policy formulation and implementation for smallholder farming development over the past decade. Through the ZRBF, UNDP and the funding partners work closely with MLAWCCR to increase the capacity of relevant government institutions and communities to build resilience against recurrent climate and non climate related shocks and stresses. ZRBF supports national surveys such as livelihoods and vulnerability assessments under ZIMVAC and poverty and agriculture related national surveys under ZIMSTATS, to inform resilience programming, in addition to capacity support to AGRITEX, DCP, FNC and others. It has recently conducted a capacity assessment of MLAWCCR to identify capacity gaps to generate evidence that can be used to influence policy interventions for resilience building[250].Throughout its project cycle, ZRBF will be implementing capacity building efforts to address these gaps.

ZRBF has also supported MLAWCCR in developing the Resilience Strategic Framework to guide programming and policy (2015). This work has involved key government stakeholders as well as development partners. The framework includes a focus on climate related risks and vulnerabilities and strategies to build resilience, particularly for rural communities. Most recently, the Resilience Strategic Framework has contributed to that considerations and climate risks and resilience building has been included in the updated AGRITEX extension policy.

MLAWCCR has also been supported by FAO to develop national policies (livestock, forestry, irrigation and mechanization) and strategies (integrated pest management, management of migratory pests, foot-and-mouth disease, and management of transboundary crop and animal pests and diseases), as well as implementation support

[249] Scaling Up Adaptation annual project reports (2015, 2016) and mid-term review (2017)
[250] MLAWCCR. Application of Evidence in Policy-making for Resilience Building Capacity Assessment Report,  DRAFT. GoZ.

to the national Food and Nutrition Security Policy, through strengthened governance and the establishment of multi-sectoral coordination committees. In partnership with other agencies such as WFP, UNICEF, and now ZRBF, FAO has supported the establishment of a national food and nutrition security information system and knowledge-sharing platform within the FNC. Between 2006 and 2014, FAO, in partnership with the SADC Famine Early Warning Systems Network (Fewsnet), supported the operation of the National Early Warning Unit to produce and distribute agricultural and food security bulletins. Additionally, FAO's DFID funded Livelihoods and Food Security Programme and the EU supported food security programme 'Forest Forces' have supported subnational and local level institutions' capacity for agriculture service delivery.

DoI has received support from FAO on irrigation design and implementation. DOI predominantly uses FAO irrigation manuals, in particular the 2002 publication[251], to understand water requirements when designing new irrigation schemes. A local publication which is difficult to source is also used. Altogether, 49 engineers and over 100 technicians refer to the FAO irrigation manuals at every stage of irrigation planning and training is usually offered to staff who have not have been trained before, usually as part of FAO implemented projects. FAO has funded all trainings so far and the last trainings for engineers and technicians were completed in 2015 under the Smallholder Irrigation Support Programme (SIP) (see section 3.3).

[251] Planning, Development Monitoring and Evaluation of Irrigated Agriculture with Farmer Participation (2002) FAO - http://www.fao.org/docrep/010/ai596e/ai596e00.HTM

# 4 Gaps in service delivery and associated barriers

Despite the GoZ and donor investments listed in the previous chapter, there are gaps in service delivery to support smallholder farmers in tackling climate risks in the short and the long term. Following an identification of priority gaps in service delivery, this chapter presents barriers to implementing interventions that have been encountered and/or foreseen, categorised as financial, institutional, technical and market-related.

## 4.1 Climate resilient approach at scale

Many interventions have taken a multi-faceted, 'resilience' approach, with commendable results achieved, namely through the coordinated efforts of ZRBF (see Chapter 3). Numerous lessons learned and best practices should be built upon (see Chapter 5). However, the most salient gap is that a comprehensive climate resilience approach has not been implemented at scale, in a coherent manner, across the southern provinces to achieve maximum impact and long-term transformational change. Such an approach, by nature, is based on the successful collaboration of multiple actors at various scales, driving forward a paradigm shift: 1) on the national level to integrate climate change adaptation into the agriculture and water sectors, in order to deliver climate resilient services to smallholders, and 2) by targeting high impact investments at the local level to address climate risks faced by vulnerable communities.

### *4.1.1 Water security provision and coverage*

There is a significant gap in the country's ability to provide secure water resources to smallholders in southern Zimbabwe in a climate resilient manner. Priority gaps in service delivery to design and implement climate resilient irrigation, as identified in the Climate Resilient Irrigation sub assessment, are as follows:

**Gaps in climate resilient irrigation design[252]:** While previous donor investments have focused on irrigation development, complimenting GoZ's PSIP (see Chapter 3), there has been a lack of a climate resilient approach to irrigation development in terms of design and selection of irrigation technologies. Previous efforts have focused on 'rehabilitating' existing and/or constructing new irrigation schemes. 'Rehabilitation' means to repair existing physical infrastructure to its original design standards, with a lesser focus on installing more water efficient irrigation systems (such as sprinkler and drip systems), in replacement of original technologies. 'Rehabilitation' efforts do not consider that the design *itself* may be inadequate to take into account changes in land and water resources as a result of climate change. This limits the impacts and sustainability of investments. A big part of this is that climate information is not used to promote more efficient irrigation (see section 4.1.4, below). DoI, responsible for irrigation design, faces challenges in climate-proofing designs, as this requires a specific technical skill set and is a relatively new area of specialisation. A related challenge is that information sources to inform design from MSD and ZINWA are often not received in a timely manner (see section 4.1.4, below).

**Gaps in support to climate resilient operation and maintenance (O&M)[253]:** A related and significant gap is support to community institutions to embed climate risk management into the O&M of irrigation schemes, to efficiently utilise irrigation infrastructure in a changing climate. While previous projects have focused on providing community institutional capacity building support to varying degrees (see Chapter 3), there is a significant gap in support to local institutions managing irrigation schemes – Irrigation Management Committees – in *climate risk management*. IMCs generally lack the capacity to maintain the infrastructure in general, however, they notably lack technical know-how to implement adaptive, climate-risk informed O&M planning. This includes the ability to operate irrigation pumps efficiently in highly variable water levels to conduct irrigation scheduling to suit shifting cropping patterns and changing seasonality. Such expertise is not provided by service providers at present, namely the extension service, AGRITEX, which relates to a capacity building barrier in government service providers (see section 4.2, below).

Management arrangements that are adaptive and responsive to constant changes in climate require accurate and timely climate information to appropriately plan and coordinate activities across IMCs. As such, IMCs and their memberships also require training in effective use and application of climate information (see section 4.1.4, below). For example, prior to a growing season, appropriate information on rainfall forecasts should inform rainfed and irrigated cropping investment proportions, and during the growing season, bi-weekly forecasts of dry dekads are essential in irrigation cycle planning and management. Without climate information to inform

[252] Cf. sections 2.3.1 and 2.3.2 in the Climate Resilient Irrigation sub assessment
[253] Cf. sections 2.3.1, 2.3.4 and 2.3.5 in the Climate Resilient Irrigation sub assessment

planning, the end result is that water, an already scarce resource, is used inefficiently, despite systems that are meant to redress this situation[254].

**Gaps in irrigation coverage[255]:** GoZ's PSIP has been successful in rehabilitating an area covering 3,500ha since 2000 on communal lands. In Manicaland and Matebeleland South provinces, FAO has rehabilitated 20 irrigation schemes covering approximately 1,000ha. SDC is rehabilitating 8 irrigation schemes in Mavingo province, and JICA is focusing on constructing a new block at Nyakomba irrigation scheme, adding an additional 146ha. DFID, through the CRIDF project, has rehabilitated two irrigation schemes in Masvingo province in Chivi and Bikita districts: Kufandada and Bindagombe. Cesvi and SAFIRE have supported the Shashe irrigation scheme in Beitbridge, rehabilitating irrigation schemes to introduce citrus trees to 90ha. Despite these significant investments, there remains a gap in coverage, at scale, particularly in rural, communal areas in the southern provinces where the vast majority of smallholders reside (see Chapter 1). Synergising with IFAD's on-going investment, which is revitalising 5,000 ha of existing smallholder irrigation schemes, mostly in communal and old resettlement areas in AERs III, IV and V in Manicaland, Masvingo, Matabeleland South and Midlands provinces, and FAO's rehabilitation of irrigation schemes in the southern provinces, provides an opportunity to complement and scale up efforts, capitalising on gains already made to achieve wide scale coverage across the southern provinces to result in a catchment-level response to responding to climate changes. Schemes identified in such investments, such as Sebasa, Chikwarakwara, Mbembeswane, Tshashani, Fuve Panganayi and Shashe, should be cross-referenced with those proposed in the target project site, to avoid duplication of efforts.

**Gaps in gender analysis in smallholder irrigation:** A further gap is analysis of gender dimensions in smallholder irrigation and ensuring interventions are gender responsive[256]. Irrigated agriculture may be an advantage for many women farmers in terms of yield increases, but it is also likely to increase women's workload, which is already significantly more than men's, as a result of women's traditional household and 'on farm' roles. There is also no understanding or agreement on the type of irrigation technology preferred by women, which could potentially make their workload easier or harder. Extension services tend to focus on cash crops, and while these are important income-generating crops, other food crops such as legumes that are cultivated largely by women, tend to be ignored. Also, in an environment where marketing outlets are few, men tend to dominate formal markets while women market their crops through local informal networks that are often less profitable. Thus, even if crops are produced for surplus, women may find it difficult to sell them. In terms of management of irrigation schemes, the post of treasurer in IMCs seems to be reserved for women, while positions of decision making are more often the domain of men[257]. However, women struggle to reach adequate levels of financial literacy, relative to men, as women face greater barriers to accessing training and knowledge and capacities may not always match responsibilities.

### *4.1.2 Gaps in service delivery to promote Climate resilient agriculture*

Despite awareness of the need for climate resilient agriculture (CRA) practices to support smallholders to mitigate climate risks and increase production, Zimbabwe does not yet have a clear action plan for promoting CRA among smallholders on a national scale and how this can be supported by government service providers, such as AGRITEX[258]. To a large extent, CRA initiatives have been isolated, confined to particular areas and groups of smallholders. Elements of CRA are promoted in many projects, and while this does contribute to reducing climate vulnerabilities, a variety of definitions and approaches to CRA adoption may complicate a coordinated response across the country. Priority gaps in service delivery to promote climate resilient agriculture are as follows:

**CRA coverage gap in agricultural extension services:** While the agricultural extension system in Zimbabwe is well structured and competently staffed from national to ward level, there are challenges in rolling out CRA through agricultural extension services at scale. During consultations AGRITEX officers expressed limited knowledge on how to integrate climate risks into agricultural planning and implementation as well as limited agronomic knowledge on the proposed climate smart crops, livestock breeds and CRA practices[259].

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[254] Manzungu, E. 1996. Contradictions in standardization: the case of block irrigation in smallholder schemes in Zimbabwe. *In:* Manzungu, E. and van der Zaag, P. (Eds.) *The Practice of Smallholder Irrigation: Case Studies from Zimbabwe.* University of Zimbabwe Publications, Harare, pp.47-68.
[255] Cf. sections 2.1 and 2.2 in the Climate Resilient Irrigation sub assessment and the Updated National Irrigation Database, Southern Zimbabwe.
[256] Annex XIII c Gender Assessment and Action Plan, p. 15
[257] Manzungu, E. and Zaag van der. 1996. Continuity in smallholder irrigation. *In:* Manzungu, E. and Zaag van der, P. (Eds.) The practice of smallholder irrigation: Case studies from Zimbabwe, Harare: University of Zimbabwe Publications, pp.1-28.
[258] Bastos Lima, N.G. 2014. Climate-Smart agriculture in Sub-Saharan Africa: A comparative assessment of challenges and opportunities in 15 countries: Synthesis report. Food, Agriculture and Natural Resources Policy Analysis Network (FANRPAN), Pretoria.
[259] During stakeholder conversations, AGRITEX staff at provincial, district and ward level expressed that they have limited knowledge on how to promote CRA practices, crop varieties and livestock breeds. March 2017, cf. Stakeholder engagement annex

**Limited, systematic adaptive knowledge management:** While initiatives and research is ongoing to support the uptake of drought and heat tolerant seed varieties, livestock breeds and other climate smart initiatives, gaps in systematic knowledge management have been identified in and across MLAWCCR departments[260]. There is limited national level collection and sharing of successes, lessons learned and failures in the attempts to promote and implement climate smart smallholder agriculture. A key issue for ensuring continual relevance of promoted CRA practices, crops and livestock breeds in a changing climate is adaptive knowledge management, where approaches are continually evaluated for their appropriateness and cost-effectiveness under the prevailing and predicted climatic conditions. Improved, adaptive knowledge management would also support the gap in up- and out-scaling of successful CRA initiatives through extension services.

**Lack of a comprehensive national policy and action plan for promoting and implementing CRA among smallholder farmers.** Currently, MLAWCCR has completed a CRA framework, which draws on the nationwide experiences of CA and CRA, but a lack of implementation plan may contribute to further isolated and uncoordinated efforts. An important aspect to consider in formulating a strategy for promotion of CRA is to base strategic options on evidence and analysis of best practice. Zimbabwe has a long history of conservation tillage and promotion of CA, as well as the importance of building on local, indigenous knowledge, which is valuable for adapting to conditions of drought. The work of the ZRBF provides a strong knowledge base for informing adaptation and resilience building strategies and policy frameworks, namely through the recently developed strategic framework for resilience, which was created through a participatory process with broad stakeholder engagement (2015). There are also good examples of how research into CRA practices and scenario modelling for adapting agriculture to future climates may be used to inform the policies and interventions to promote CRA practices, crops and livestock breeds. Together with DR&SS and AGRITEX, ICRISAT has modelled climate adaptation scenarios for one district in Matabeleland North with good results.

### *4.1.3 Gaps in linking farmers to climate resilient, inclusive markets*

While numerous donors have supported the introduction of new climate resilient agricultural practices, farmers still struggle to commercialise. Increasingly, projects have taken on a market approach, linking smallholders to markets, training farmers in ‘farming as a business’ and facilitating access to finance. This has yielded better results, but there remain significant gaps in ensuring farmers are able to sell their produce in markets – especially if new climate resilient products are introduced. Priority gaps in linking farmers to climate resilient, inclusive markets are:

**Limited service provision from AGRITEX Extension Officers to link smallholder farmers climate smart crop production and markets:** The private sector plays a crucial role across the agricultural value chains as providers of input, technical support to production and buyers of the produce.

In order to ensure households’ income security to build resilience to increasing climate change impacts, farmers need to both grow and effectively market their produce. Most smallholders are used to producing for their own food security or to an unidentified market, and often end up producing the same cash crops as nearby farmers, resulting in lower prices and with no ready formal or informal market to off take the produce. This is shown quite starkly in the fact that in almost all irrigation schemes visited during Feasibility Stage, farmers’ cropping calendars (which determine farmers’ crop choice for the season) bore no reference to market demand[261]. At Nyanyadzi irrigation scheme, for example, farmers could not remember when their calendar was developed, and concurred that it did not respond to market trends[262]. Many schemes do not identify a ready market before growing and therefore have challenges selling produce. This will especially be important to deal with in the case of newly introduced climate resilient crops.

The services of AGRITEX are limited in terms of identifying opportunities for smallholders to link up with conventional, formal markets, and even more so when new climate resilient crops are introduced. AGRITEX Officers express that they struggle to provide farmers with the right support related to ‘farming as a business’, market analysis for climate resilient crops and livestock as well as knowledge and networks to improve market links[263].

**Limited service provision of AGRITEX to support smallholders to assess climate risks in agricultural production and develop climate resilient value chains:** Limited assessments of climate risks in agricultural production and value chains is a significant gap in the training provided across the majority of market related interventions for smallholders to mitigate climate risks. At the same time, it is necessary to work with

[260] CRA packages sub assessment, p.23-25
[261] Value Chain Sub-assessment.
[262] Ibid.
[263] March 2017, Consultations. Cf. Stakeholder annex

agribusinesses to embed climate resilience into their business models. This may entail providing farmers with training in CRA and a designated technical resource to support production operation over the season. Other than USAID, EU and DFID, few donors have focused efforts on agribusinesses themselves. Integrating climate risk considerations in value chain development allows a number of climate-related bottlenecks that limit production to be addressed. Such bottlenecks include: climate-induced production constraints that results in farmers failing to meet levels of demand; climate change-induced extreme weather conditions that affect storage and transportation to the market; and high climate risk exposure that makes microfinance institutions avoid funding smallholder agriculture. There is limited capacity in AGRITEX to assess climate risks and exposure for smallholder farmers, to identify emerging climate resilient market opportunities for smallholders as well as facilitation of climate change considerations throughout the value chain[264].

**Limited analysis to gender equal participation and gendered climate risks in value chain development:** Additionally, a fundamental gap in efforts is the lack of integration of gender analysis into value chain interventions[265]. Despite constituting the majority of the rural agricultural farming sector, the challenges faced by women across value chains are not sufficiently addressed at scale and most interventions do not take into account the specific set of climate related vulnerabilities women face. Women do not have equal access to land as their male counterparts in both communal and resettlement areas. Mostly, women access land indirectly through marriage, and in situations where they own their own land, it is often under dispute. The lack of access to assets in turn inhibits women to access loans and credit facilities, which are pivotal to their economic development. In relation to climate risks, value chains experience different exposure, which may disproportionately affect men and women, depending on the value chain. Also, climate change impacts on gendered ways of marketing produce, are rarely considered.

### *4.1.4 Gaps in climate information services*

There is a significant gap in the country's ability to collect weather/climate information: there are not enough weather stations to achieve a full observational network and therefore generate a timely and accurate 'picture' of climate and weather related risks. While previous investments (see Section 3.6), have focused on collecting weather/climate information, there is also a significant gap in the development and dissemination of *climate-related* information which can be used to inform decisions and which is combined with other non-climate information to inform expected risks. Some isolated interventions in recent years, such as UNDP/GEF's project (see Chapter 3), have made progress, but these have largely focussed on small regions. Also for interventions with national climate information components, such as the recently approved GCF funded project" Integrated climate risk management for food security and livelihoods in Zimbabwe focusing on Masvingo and Rushinga Districts" with WFP as Accredited Entity, gaps remain in both scale and capacity to generate/disseminate information. **This prevents GoZ providing an accurate and timely picture of the country's climate risk profile to inform climate risk management for service providers and farmers.** This gap is complicated, as various institutions take part in the climate information system (see section 4.2, below), and gaps to collecting, analysing and communicating accurate climate information are associated with providing useful and relevant information on streamflow, temperature and rainfall (weather and hydrological monitoring and forecasting), as well as the ability to monitor and forecast extreme droughts, storms and flood risk. Further, the ability to provide this information is dependent on the effectiveness of both weather/hydrological gauging stations in terms of the adequacy of coverage and the density of the networks and the capability of infrastructure to respond to new challenges caused by climate variability and climate change. It is also dependent on access to forecasts (both globally and locally), as well as maintaining the capability to tailor the information based on the requirements of the users/decision makers who will use the information. In turn, these requirements are heavily dependent on human and institutional capacity, in both recording and communicating data to service providers, relevant institutions and farmers.

**Gaps in weather and seasonal forecasting and monitoring:** The MSD faces several challenges in weather and climate information generation and dissemination. This is partly due to the low density and state of the network of synoptic and rainfall stations. As a result, MSD cannot provide an effective weather forecasting system for normal forecasting activities and early warning to alert people of impending weather-related threats[266].

*Gaps in the weather station network: spatial observations*

The MSD is planning to replace 47 manual synoptic weather stations with AWS, instead of trying to repair obsolete equipment. MSD would also like to increase the network of voluntary rainfall stations, though the extent to which this is possible depends on availability of equipment and willingness of volunteers to send data – which

[264] March 2017, Consultations. Cf. Stakeholder annex
[265] Value chain sub assessment, p. 76 ; gender annex, p. 10-11
[266] Banda, J. 2013. Status and priority needs of monitoring and predicting climate anomalies and extremes in Zimbabwe. Available on: http://www.wmo.int/pages/prog/wcp/wcdmp/documents/Zimbabwe.pdf (Accessed 4 July 2016)

in economically disadvantaged communities will be difficult[267]. Nevertheless extra stations will improve weather monitoring capabilities. In turn, it is expected that this increased capability to monitor the current status of weather in the country will improve the ability to verify forecasts (in retrospect), as well as be able to adjust current forecasts based on the observations. In the long term (3+ years), there will be the potential to start developing statistical weather forecasts (Model Output Statistics) based on new weather station data. However, as pointed out in the following section (see section 4.5), there are several barriers to being able to install a dense network of AWS, not least the capability and finances to operate and maintain a dense network of ground-based stations. An additional consideration when installing a network of AWS is the availability of data and time it takes to make observations available – both for weather forecasting and to other users of the information e.g. ZinWA (for water modelling) and AGRITEX for agricultural assessments. Proposed solutions include the use of secure cloud storage to provide access to other institutions besides MSD, as well as the use of Frontline SMS for collecting data from manually operated synoptic stations[268]. Subsidies for rainfall-only and volunteer stations need to be reinstated as ways of communicating the data.

*Use of satellite-based information*

One alternative to the use of ground based weather stations (which have a small footprint and sample a relatively small area), is the use of complimentary satellite data/observations, which is currently not used to the extent it could be. These data are not a substitute for weather stations and may be biased with respect to available weather station data. They can however be used to extend the weather station data into areas/regions where there are no weather stations, by using the weather station data to debias the satellite estimates e.g. of rainfall. Whilst satellite data (Meteosat 2nd generation - MSG) is used by MSD to observe developing thunderstorms and rainfall bearing systems, and is included in the qualitative generation of forecasts, there does not exist a quantitative process for including its use. This key gap is because: a) human technical capacity to manipulate the data and run algorithms is limited; and b) access to computer hardware to hold the data and generate rainfall estimates is limited[269].

A further advantage of developing satellite based products is that it can be used to support the use of private sector based Weather Information Insurance for risk management, such as the ZimNat Pundutsu service.

*Forecasting capabilities*

Whilst high resolution spatial observations are a major gap to improving climate risk management in agricultural livelihoods, it is not the only requirement to be able to provide more accurate and useable forecasts. The ability to forecast the future evolution of the weather and climate is dependent on access to forecast models, which can predict the future either through simulating the evolution of the atmosphere directly (physical models), or using the status of current conditions to statistically predict future conditions. The current forecasting system utilises globally available weather forecasts from the GFS and ECMWF, which are then interpreted based on observations from weather stations, satellite observations and forecaster experience[270]. This process is qualitative in nature and results in a qualitative forecast for wide regions which limits its application for specific sites and to use it for calculating specific tailored forecasts for agriculture e.g. rainfall intensity, amount of rain to fall in 48 hours etc. Two ways of addressing this gap would be to develop statistical relationships between the GFS/ECMWF forecast fields and historical observed weather station data (MOS described above), or to run a regional climate model. The MOS approach is the simpler and less computationally intensive process that can also be extended to include new AWS data when sufficient time series are available. The requirements are: a) people with sufficient training and capabilities for undertaking statistical analyses; and b) access to hindcasts from the GFS and ECMWF models (currently available) and desktops with sufficient storage space and statistical software (there are packages available which utilise the freely available R software). The latter option requires: a) access to high-end computational servers (either through cloud computing e.g. Amazon, or through local High Performance Computing facilities); b) available internet bandwidth to both access the computing resources and download very large boundary condition files from the GFS/ECMWF forecasts; and c) human capacity to run regional climate models, diagnose problems and interpret their output. These are current gaps in the system which will need supporting if progress is to continue.

MSD utilises the most popular seasonal forecasting tools in the SADC region, namely GeoCOF and CPT. It also participates in the SARCOF process and is involved in developing the SARCOF regional product[271]. However, this product is not useful for many decision-makers as the use of probabilities is confusing and often the probabilities are close together i.e. there is not a significant difference in the probability of normal and above-normal rainfall. There is however, potential to develop more specific binary/decision tree type forecasts, as was

[267] Consultations with MSD, Mark Tadross, 2017, cf. stakeholder annex
[268] Innovation for climate adaptation report. (2016) Digital velocity – Scaling up adaptation to climate change project. pp 47.
[269] Consultations with MSD, Mark Tadross, 2017
[270] Consultations with MSD, Mark Tadross, 2017
[271] Consultations with MSD, Mark Tadross, 2017

demonstrated in UNDP/GEF's coping with drought project, which developed a drought/no drought forecast. This was shown to be more accurate/reliable than the traditional seasonal forecast, as well as more useful to farmers.

*Communicating weather and climate information*

There are gaps regarding how to effectively communicate weather forecast information to farmers, including[272]: capacity of farmers to understand and interpret forecasts; ii) the ability of forecasters to provide simple interpretations in normal/everyday language; iii) dissemination of forecasts in time to be used for decision making; iv) lack of credibility if forecasts are often wrong; v) use of inappropriate communication channels; vi) requirements for forecasts at a finer scale (though this may not be scientifically feasible)[273]; vii) users being able to provide feedback and contribute to the design of products. Lastly, there is a tendency to expect farmers and water managers to be able to interpret forecasts in terms of their own decision frameworks, whereas in reality there is a need to provide relevant context material or translate the forecasts into more useable information e.g. into water resource assessments, information on the start/end of the rains, expectations to meet crop water demands etc.

To some extent these issues are being addressed by current pilot efforts, notably projects by Practical Action and UNDP/GEF projects (see Chapter 3). However, there is still room for improvement, particularly around upscaling, packaging and the active involvement of farmers in data collection, as well as ensuring there are effective communication channels between experts and the end users. In particular, there needs to be continuous development and improvement of the information content within tailored advisories, which requires continuous interaction between MSD, AGRITEX and farmers. This will allow more varied communications/messages to be developed for specific locations and for particular situations/climate forecasts. Importantly, these communications need to be useable to farmers, which means that farmers need to be able to translate a particular warning based on available options the farmer has. This requires a deeper understanding of options that are specific to particular farmers, as well as training for farmers to be able to interpret weather/climate forecasts given their set of unique circumstances. Again, this requires a long-term training and engagement activity similar to that undertaken through the PICSA approach in other countries in Africa[274]. The PICSA approach is also expected to be used in the recently approved GCF supported project "Integrated climate risk management for food security and livelihoods in Zimbabwe focusing on Masvingo and Rushinga Districts" with WFP as accredited entity, opening up avenues for synergies across interventions.

Indigenous knowledge is acknowledged by many communities as key in climate information systems in Zimbabwe. An ongoing study by the University of Zimbabwe seems to point to this fact[275]. The elderly in some communities sometimes can make predictions on the quality of agricultural seasons. Links between indigenous knowledge and weather/climate forecasts offer one way to engage farmers and other potential users. By translating scientific forecasts into locally relevant/believed forecasts or by showing the links between the two, debates and engagement with local communities can be enhanced. However, there has been limited investments towards validation of indigenous knowledge systems to incorporate knowledge into formal climate information systems. See annex 17 for an overview of how indigenous knowledge may be useful for weather forecasting.

**Gaps in hydrological monitoring and water resource management/planning:** As part of its mandate, ZINWA runs a network or river and dam gauging stations that measure flows at 105 locations in the Save, Runde and Mzingwane catchments (Figure 22). These stations are in different states of functionality, with some stations needing repairs to dataloggers, flumes, gaugeplates and in some cases desilting[276]. Whilst there is a clear need for new gauging stations (particularly in the western Save catchment and towards the south and east of all three catchments), it is important that any repairs are only considered for gauges which have an existing observer and the long-term prospects for operating and maintaining this infrastructure is good.

[272] Gaps identified in UNDP/GEF Scaling Up Adaptation project and in consultations with MSD, Mark Tadross, 2017
[273] In some cases farmers fail to take advantage of favourable forecasts due to issues regarding access to inputs (cost and/or availability) such as seed, fertilizer and draught power.
[274] University of Reading. Climate Services for Smallholder Farmers. Available on: https://www.reading.ac.uk/imagine/Projects/Imagine-PICSA.aspx (Accessed 5 May 2017). The PICSA approach is also expected to be used in the recently approved GCF supported project " Integrated climate risk management for food security and livelihoods in Zimbabwe focusing on Masvingo and Rushinga Districts" in Zimbabwe through WFP as AE
[275] Conversation with researcher Juliet Magwenzie, UZ, September 2017
[276] Consultations with ZINWA, Mark Tadross, 2017

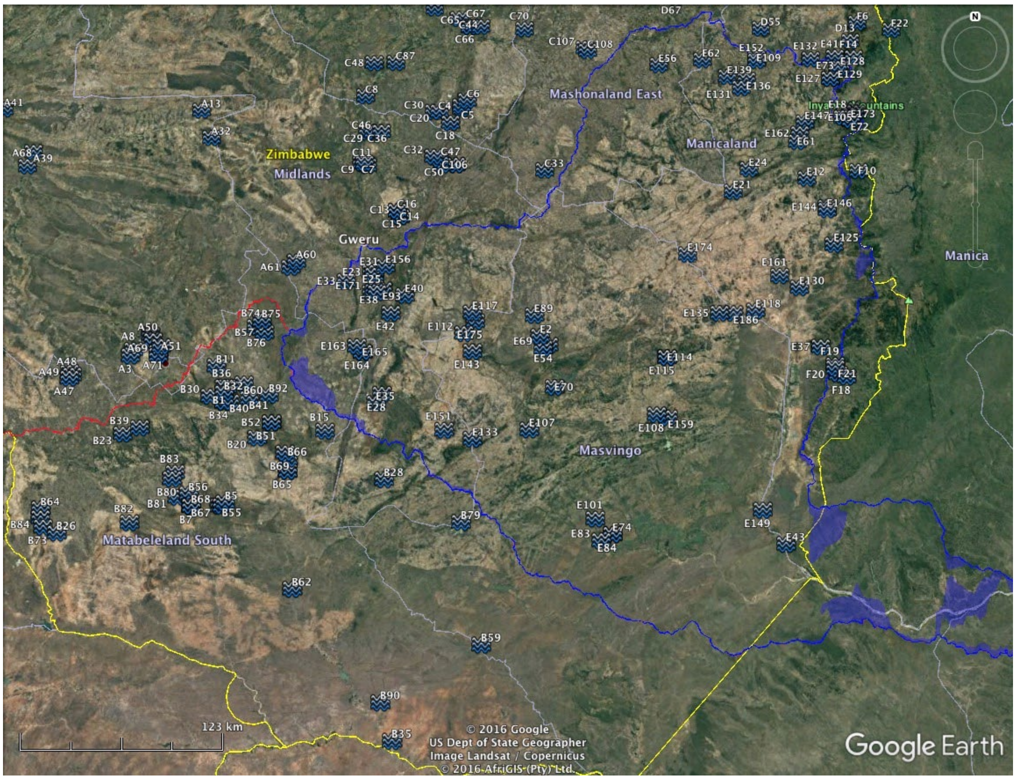

Figure 22: Locations of hydrological gauging stations in the Save, Runde and Mzingwane catchments (delineated in red and blue lines)
*Source:* Charles Sakuhuni, ZINWA[277]

A large part of the stations are not functional (Table 9). As a result, monitoring the state of water resources and water levels in the three basins is difficult, with only patchy information available at any one time. In part, this is also due to reporting arrangements and a lack of automatically transmitted data. The last survey undertaken in the Save, Runde and Mzingwane catchments was conducted in 2011[278]. As with meteorological stations, it may be cost effective to install new stations rather than repair outdated ones, depending on the current state of the observing equipment, and the need to keep manual observers in place/employed in some locations. OTT Equipment is a preferred vendor for ZINWA observing stations, largely because of its durability and ease of operation and because ZINWA engineers have previous experience operating and maintaining this equipment.

Table 10: Number and status of gauging stations in the Save, Runde and Mzingwane basins

| **Catchment** | **Total number of stations** | **Number of operational stations** | **No. of non-operational stations** | **% non-operational stations** | **Remarks** |
|---|---|---|---|---|---|
| Save | 66 | 49 | 17 | 26 | 16 stations are not manned. There is need to install data loggers on unmanned stations or recruit observers. The stations generally need maintenance works which include desilting repairs to access roads and leak repairs. |
| Runde | 173 | 96 | 77 | 45 | There is a need to carry out maintenance works on most stations. Siltation and leakages are the major problems. Data loggers must be installed on some stations to improve coverage and data quality. |

[277] Mazvimavi, D. 2003. Estimation of flow characteristics of ungauged catchments: Case study in Zimbabwe. Published PhD thesis. Wageningen University, The Netherlands.
[278] Consultations with MSD, Mark Tadross, 2017

| | | | | | |
|---|---|---|---|---|---|
| Mzingwane | 150 | 75 | 96 | 64 | There is a need to carry out maintenance works on most of the stations. |
| Total | 389 | 220 | 169 | 43% | |

*Source*: ZINWA, Consultations with MSD, Mark Tadross, 2017

The same challenges that affect surface monitoring are true if not worse for groundwater monitoring. Understanding groundwater withdrawals over time is important, especially as the relationship between withdrawals for agriculture and for other competing needs, such as domestic purposes and for livestock watering, is crucial for the productivity and ability of farming communities in rural areas to carry out daily activities. This competition for groundwater needs careful analysis in the face of climate change both in terms of recharge rates, as well as the potential for increased withdrawal pressure, as irrigation needs rise in the face of varying rainfall patterns and amounts. ZINWA does not have the capacity to do this at present.

ZINWA also needs to ensure dam inspections and silt surveys are conducted regularly to establish sediment loads and to monitor loss of storage due to deposition of sand and silt in dams. ZINWA normally conducts annual sediment surveys on strategic river locations to monitor sediment loads. However, the 59 monitoring stations around the country are not adequate to achieve full and accurate records. This is compounded by limited capacity to interpret such information, which is further compromised by the lack of consistency in the points that are monitored. Consequently, there are very few complete data sets for any single station, which makes it impossible to reach accurate conclusions on sediment loads and silt surveys. Heavy rainfall, storms and flooding in ecologically fragile landscapes often lead to siltation of water ways. Additionally, periods of reduced rainfall have led to an increase in river and stream bank cultivation by communities in the Save river basin, which in turn promotes soil loss and sedimentation. Climate change is projected to reduce the average amount of rainfall during the main rainfall season, as well as potentially increase the intensity/likelihood of heavy rainfall[279], thus promoting further siltation and reducing the water storage capacity of dams, which in turn affects the ability to meet water demands.

ZINWA uses the HYDSTRA database[280] to archive and analyse its observations collected through the hydrological station network and an in-house water resources model, coded in FORTRAN. There is need to build further capacity on the use of HYDSTRA for data capturing and data analysis as well as other models that can be used for water resources management, such as WEAP[281]. Just as is the case with MSD, ZINWA has suffered brain drain and lacks sufficient manpower to systematically and operationally utilise these data and models[282]. So far, three engineers have been trained to use the WEAP model and eight engineers can utilise the Pitman model, but in order to ensure sustainability and develop capacity in the individual river catchment authorities, it is necessary to train a further 10 engineers, as well as conduct refresher training for these hydrologists (who will need to supervise the river catchment authorities). Additional capacity will need to be developed if WEAP and/or the Pitman model is to be used in an operational setting and use existing and planned hydrological observations, as well as seasonal climate forecasts to project impacts on water resources. This capacity will involve the development of code and scripts to extract and process data from HYDSTRA and from MSD. Probabilistic seasonal forecasts will need to be translated into probabilistic rainfall totals using Monte Carlo simulations and along with WEAP/Pitman used to assess the probability/risks of different levels of water availability and dam yields.

**Gaps in the National Early Warning System for agriculture and food security:** The NEWU faces challenges in coordination, collation and synthesis of climate data. This is due to two main factors. First, the challenges facing MSD discussed above directly affect the operations of the Unit. This is because the Unit relies on climate data in forecasting food security situations. Secondly, there is the need to be able to synthesise climate data into more useful formats and information e.g. impacts on crop production in different localities. Thirdly, NEWU lacks capacity in modelling prices of agricultural produce using different climate scenarios.

## 4.2 Key barriers to supporting rural agricultural livelihoods

### *4.2.1 Financial barriers*

While GoZ regards climate change as one of the major threats to the country, its efforts are constrained, most significantly, by limited fiscal capacity. GoZ does not have enough financial resources to allocate adequate investment to design climate risk management strategies in service delivery to support adaptation and mitigation activities, nor implement them. This is indicated most profoundly by diminishing budgetary allocations from Treasury to government departments key to building climate resilience. Table 11 shows the decreasing trend between 2014 and 2016.

[279] Bellprat, O. et al. 2015. Unusual past dry and wet rainy seasons over Southern Africa and South America from a climate perspective. Weather and Climate Extremes. 9, pp.36-46.
[280] KISTERS Pioneering Technologies. 2014. KISTERS. Available on: https://kisters.com.au/hydstra.html (Accessed 19 May 2017)
[281] WEAP. 2017. Water, Evaluation and Planning (WEAP). Stockholm Environment Institute. Available on: http://www.weap21.org/ (Accessed 19 May 2017)
[282] Consultations with MSD, Mark Tadross, 2017

Table 11: Budget allocations for GoZ departments key to climate resilience building

*Source:* MFED (2015)

| Sector | Budget(USD) | | |
|---|---|---|---|
| | **2014** | **2015** | **2016** |
| Meteorological Services | 3,838,000 | 2,926,000 | 2,330,000 |
| Water Resources Management and Development | 79, 227, 000 | 40, 439, 000 | 28,564 000 |
| Civil Protection | 550, 000 | 350,000 | 360,000 |
| Veterinary services | 22,109,000 | 19,008,000 | 12,850,000 |
| Agricultural and Extension Services | 36,183, 000 | 35,110,000 | 19,599,000 |
| Irrigation and Development | 15,218,000 | 10,703,000 | 7,147,000 |
| Livestock Production and Development | 6,697,000 | 5,082,000 | 5, 558, 000 |
| Agricultural Engineering and Mechanisation | 4,760, 000 | 5, 285, 000 | 3,531,000 |

While already committed budget allocations, such as ZAIP's (2013-2018) US$4.69 billion[283], are positive indications of GoZ's intention to build climate resilience in the agriculture and water sectors. Table 12 below shows actual disbursements have been significantly lower. See Annex 18 for a more detailed ZAIP budget breakdown. In the 2012 National Budget, agriculture was allocated 8% (US$317 million), 80% of which went towards recurrent expenditure.

Table 12: Budget allocation of ZAIP climate-sensitive activities per sub-sector

*Source:* World Bank (2015)

| **Sub-Sector** | **%** | **US$ '000** |
|---|---|---|
| Rain fed | 14 | 261,905 |
| Irrigation | 55 | 1,001,940 |
| Livestock | 8 | 136,866 |
| Cross cutting | 23 | 407,593 |
| Total Climate-Sensitive | 100 | 1,808,304 |

The impact of limited fiscal capacity on the principle departments involved in building climate resilience: MSD, ZINWA and AGRITEX, is significantly damaging. **MSD and ZINWA** do not have enough funding to invest in the required weather/climate and hydrological monitoring infrastructure to gain an accurate picture of climate risks in agricultural livelihoods[284]. The cost of wide-scale site identification, installation, maintenance and monitoring of the stations (whether automated, manual or voluntary), is beyond the financial capacity of these departments, as well as the funding needed to upgrade the gauging stations and process the information gathered (regarding both analysis and dissemination). **AGRITEX** lacks the financial capital to invest in training courses for Extension Officers in CRA, climate risk management for adoption by rain-fed and irrigated farmers, and training in 'farming as a business'[285]. There is a lot of potential scope for improving the training, as necessary baseline investments are in place: GoZ has invested in developing Agricultural Training Colleges across the country (see Chapter 2) [286]. It is also important to note that despite limited fiscal space; most training centres have devised means to self-sustain, reflecting the drive of GoZ institutions. However, there is limited financial capacity to develop new curricula that addresses climate change, as well as re-train existing Extension Officers in such curricula. Developing context specific training materials for each region and capacitating training centres to

[283] MLAWCCR. 2013. ZAIP (2013-2018). A Comprehensive Framework for the Development of Zimbabwe's Agriculture Sector. GoZ, Harare.
[284] Consultations with MSD and ZINWA, Mark Tadross, March 2017
[285] Consultations with AGRITEX, March 2017, cf. stakeholder engagement annex
[286] MLAWCCR. 2017. Agriculture Colleges. Available on: http://www.zarnet.ac.zw/dev/govportal/agric_services/agriculture-colleges (Accessed 5 May 2017)

deliver relevant training to extension staff and lead farmers requires additional financial resources that GoZ does not have.

Such national level fiscal constraints in both Treasury and government departments inevitably has severe implications on institutions across all levels, particularly the institutions which are public facing and providers of knowledge and services to farmers. It is also important to note that the economic situation of debt and an unfavourable balance of payments, presents an environment that is not conducive to private sector investment in public goods, especially for the very poor.

### *4.2.2 Institutional barriers*

#### *4.2.2.1 Implementation of a coordinated response to climate change by government service providers*

GoZ, with support from development partners such as UNDP, FAO, DFID and EU has made significant progress in mainstreaming climate change considerations into development policy and planning, most notably with the finalisation of the NCCRS and the National Climate Policy, and has developed a framework for coordination of strategic responses (as set out in the National Climate Policy) (see Chapter 2). The recent Resilience Strategic Framework (2015) provides a strong conceptual framework for building resilience to climate change impacts. These frameworks will guide formulation of new policies, such as the CRA policy, while some of the existing policies and planning frameworks such as the Comprehensive Agriculture Policy Framework (2012-2032), the ZAIP, the Irrigation Policy, Irrigation Master Plan and the Water Policy would benefit from a policy review focused on mainstreaming climate change.

Also, Zimbabwe's agriculture and water sectors have very well developed institutional structures to deliver services at every level (see Section 2.2). However, a significant barrier is a lack of *implementation* of a coordinated response to climate change, especially in the management of multiple stakeholders across the water and agricultural sectors, whose collective activities build resilience to climate change. This transcends state agencies, the AGRITEX extension service, research institutions, private companies, IMCs and farmer associations. A lack of coordination by government service providers contributes to inadequate service provision to smallholders. Existing resource, technical capacity and operational challenges in key departments such as AGRITEX, ZINWA, and MSD constrain coordination efforts for climate resilience building[287]. This coordination barrier is mirrored at subnational and district operational levels, where the same institutions are represented.

This is to a large extent caused by policies and mandates that are in many cases overlapping, or at least converging. For example, at the catchment level responsibilities overlap between ZINWA, Catchment and Sub-Catchment Councils, AGRITEX and EMA. This causes duplication in effort and parallel structures. It is also compounded by the high turnover of staff across all government departments key for building climate resilience, particularly within MLAWCCR, and, notably, in AGRITEX. There are not sufficient retention incentives to keep staff employed, resulting in a lack of institutional knowledge and a lack of investment in key skill sets required for designing and implementing climate resilient interventions[288].

Weak horizontal and vertical coordination also limits the capacity to manage and share knowledge and capitalise on synergies across departments. This is particularly pertinent in the climate information system, where a number of government departments, including MSD, ZINWA, AGRITEX, Department of Civil Protection and the NEWU, participate at different levels in the generation, processing, and dissemination of climate/weather products and agriculture advisories[289]. They are expected to converge and support one another to achieve a product that corroborates data from each institution, especially when advisories on climate, disaster preparedness, recovery and resilience for public use are developed. This, however, is not happening sufficiently. There is a lack of established mechanisms through which data sharing can easily be facilitated e.g. ZINWA does not share data from weather/hydrological stations with MSD, and MSD does not make weather station data available in real time to ZINWA for flood/water resource modelling purposes and to AGRITEX for developing tailored advisories.

Lack of communication across departments, particularly between AGRITEX, MSD and ZINWA, presents a barrier to enabling AGRITEX to support farmers to receive information, training and services specific to their agro-ecological conditions[290]. Both ZINWA and AGRITEX interact with MSD at different scales (national, provincial and district) because of their different requirements for weather and climate information; ZINWA tend to need provincial-scale data to assess likely changes in runoff into the major dams, whereas AGRITEX are more interested in district-scale information (or finer), which relates to farms and local communities. Whilst these organizations interact through Drought Relief Committees and DRR-focussed meetings, there is scope to increase

[287] CRA validation workshops, June 2017.
[288] Consultations with AGRITEX, March 2017
[289] Consultations with MSD, AGRITEX, ZINWA, March 2017
[290] Consultations with MSD, AGRITEX, ZINWA, March 2017 / UNDP/GEF Scaling Up Adaptation

interactions between MSD, ZINWA and AGRITEX, especially at ward level and with Irrigation Management Committees when discussing water allocations for irrigation schemes.

#### *4.2.2.2 Service providers and community interface*

There are challenges in establishing a good working relationship at the service provider-community interface. Smallholder farmers tend to view many representatives of state agencies as 'taxmen', who do not have an interest in engaging and supporting their agricultural livelihoods. For example, farmers' limited engagement with members of state agencies responsible for water, namely ZINWA, Catchment Councils and Sub-Catchment Councils, has led to some farmers expressing that their only interaction is when Officers deliver water bills, adjust water outlets to regulate water outflows from dams, and enforce rules and regulations. Farmers instead expect ZINWA and the Councils to act as facilitators to support them in water efficiency techniques and good catchment management practices[291]. In some instances, the mismatch of expectations has led to animosity between farmers and water agencies. In one case, farmers in Block B in Musikavanhu irrigation scheme took the Sub-Catchment Council to court in Chipinge town. In another, women farmers in Oatlands irrigation scheme were sued by the Mutirikwi Sub-Catchment Council. Tension sometimes also arise between farmers and ZESA, responsible for energy supply. An area of tension is concerning the energy bills ZESA presents to farmers, as farmers experience unreliable and infrequent energy supply, and often do not have confidence in bills issued. If farmers do not pay, their energy supply is cut off, preventing irrigation from taking place.

This tension between smallholder farmers and government service providers may be attributed to that there is no platform for the various stakeholders to collectively discuss roles and expectations and collaborate around challenges and opportunities in building climate resilience.

The relationship between farmers and AGRITEX Officers on the other hand seems to be working very well, albeit technical and financial constraints. This is perhaps attributable to the fact that AGRITEX Officers are present at the ward level, allowing more face-to-face interactions on a daily basis, and being knowledgeable about the daily challenges faced in farming livelihoods, supporting where they can, albeit with limited resources[292].

#### *4.2.2.3 Institutional barriers at community level*

Changes in climate require community institutional arrangements to be adaptive and responsive, building climate risk management into their set-up and operations[293]. The extension service provided by AGRITEX, which is the most importance source of advice for small holders in making decisions on crops and agricultural practices[294], does not equip farmers to adequately respond to climate change impacts. This presents a significant challenge at the community institutional level, and exacerbates barriers such as poor management and governance practices to enable communities to work collectively (rather than on a plot by plot basis) to capitalise on economies of scale. Such challenges are perhaps related to the nature of the set-up of community institutions: most are created by GoZ or donor for specific purposes, which, when support wanes, so do the institutions. However, there is also the tendency for communities to depend on government and donor interventions, rather than to take on responsibility as a group. There is also an aspect of unmet needs and expectations: when institutions are set-up for a specific purpose, and communities invest time, resources and energy into defining the support they need, if such support is not received, the social contract is eroded, negatively impacting communities' perspectives regarding the point of such time and energy investments and the potential success of such efforts.

Weak and dysfunctional IMCs are common across many schemes[295,296]. A lack of consideration of climate risks in their management arrangements and depressed farmers' incomes due to climate-induced water scarcity, which reduces production, exacerbate issues such as poor leadership and conflicts over cropping decisions, pumping schedules, unpaid fees etc. Schemes are primarily diesel-based, requiring high capital and maintenance costs. Most often, farmers are not able to meet their financial obligations towards electricity payments to ZESA, and those connected to the grid experience regular power cuts that affect production, also contributing to low returns and unsustainable O&M of the schemes. This is in part due to inappropriate design (that is not climate-proofed) and poor governance and management arrangements (that are not climate risk-informed), and is compounded by climate-induced water scarcity affecting production. Such problems result in friction, and, in some instances,

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[291] Stakeholder consultations, March 2017
[292] Stakeholder consultations, March 2017
[293] Cf. Irrigation Sub assessment, Lessons Learnt chapter, 44-56
[294] Moyo, M. *et al.* 2017. Irrigation development in Zimbabwe: understanding productivity barriers and opportunities at Mkoba and Silalatshani irrigation schemes. International Journal of Water Resources Development. 33(5), pp.740-745.
[295] Ibid.
[296] ZimVAC. 2016. Zimbabwe Vulnerability Assessment Committee 2016 Rural Livelihoods Assessment. SIRDC. ZimVAC, Harare.

disagreements among plot holders have led to farmers dropping out of schemes, and even the disintegration of IMCs.

#### *4.2.2.4 Knowledge management*

There is a significant lack of knowledge management in collecting and sharing experiences in best practice, innovations and lesson learning in responding to climate change, across all institutional levels and stakeholders involved in the agriculture and water sectors[297]. This presents a significant barrier to building climate resilience, as climate change adaptation of agro-ecosystems and agricultural production to increasing climate hazards is a knowledge-intensive process based on experience from practice and the collective and adaptive learning of all stakeholders to respond to changing climate risks. Ideally, such experiences should feed-up to the national level through mechanisms and platforms for knowledge capture and exchange, to influence policy decision-making and be scaled out through extension services.

According to a needs assessment of the Department of Economics and Markets[298], the department has no strategy yet for information management. It is in the process of developing one, but in the meantime, pieces of information are collected and hosted by different units, which are not linked into one comprehensive information system for agriculture that is easily accessible for all users. The Department also does not have the necessary hardware and software to establish a database, and there is a lack of human capacity to implement an information system. Information is presently being stored on a single computer. This is also the case in other departments in the agriculture sector, resulting in staff working in parallel and not feeding information into a national monitoring system to measure progress towards the expected results of the sector[299].

In the case of climate and weather information, there is a lack of climate change data sharing between key departments, particularly AGRITEX, DR&SS, MSD, and ZINWA at the national level, due to a lack of established mechanisms to facilitate information sharing and institutional inertia and politics[300]. This results in crucial information not being passed onto the sub-national level and farmers, particularly to rural areas beyond urban-hubs. At the sub-national level, agriculture institutions, including Agricultural Training Colleges, DR&SS research stations and AGRITEX offices, lack the capacity to generate and disseminate technical information on climate risk management to farmers. While such structures act as a resource hub for AGRITEX, they are often not very accessible to farmers and do not provide context-specific materials for farmers to take away with them, thus operating more of a research hub for AGRITEX than farmers. Farmers and IMCs rely on AGRITEX Officers to provide weather information[301], and Officers rely on the information they receive via email or SMS from national headquarters and MSD. This situation can be greatly improved by providing materials (e.g. explanations of simple weather/climate processes such as climate change, El Niño and their impacts on water and agriculture) in local languages, integrated with exiting indigenous knowledge and ways of forecasting. The development of these facilities will need to encompass joint efforts by MSD and AGRITEX utilising appropriate, existing centres and community spaces e.g. AGRITEX offices and DR&SS research institutions[302].

Mechanisms for knowledge exchange between farmers at the local level are often weak, often needing external facilitation, and are not taken up to the district, provincial or national level to generate learnings that may be replicable and influence policy. There is need to build a sense of local ownership, facilitate coordination for knowledge exchange, and strengthen governance and management systems.

### *4.2.3 Technical barriers*

The below sections, which depict technical barriers to building climate resilience, should be considered relating to both the capacity of **service providers**: GoZ departments and agencies, donors, NGOs, CSOs, FBCOs, research institutes etc. and **'end users'**: smallholder farmers, IMCs, farmers' associations etc. They are inextricably related. While there is a good foundation of baseline investments, an advanced institutional framework, and a more than capable human resource base, there is room for improvement to strengthen the contribution of all actors.

[297] CRA package sub-assessment, p.23-25
[298] Mukorera, O. 2015. Report on Needs Assessment within the Department of Agricultural Economics and Markets. MLAWCCR, GoZ.
[299] CRA package sub assessment, 23-25
[300] Consultations, March 2017
[301] Community consultations, March 2017;
[302] As per experience from UNDP/GEF project Scaling Up Adaptation

#### 4.2.3.1 Capacity to design and implement climate resilient irrigation schemes

Within the Zimbabwe market, in GoZ service providers, private companies and individual professionals, such as engineers and technicians, there is a lack of technical capacity to design and implement rural, small-scale climate resilient irrigation schemes. DoI's capacity base and the exceptional roster of qualified engineers and technicians (firms and individual consultants) that exists, should be built on to address the capacity gap of applying hydrological assessments and flood forecasting into design to account for climate risks[303]. There is also a variety of high-quality solar installation companies with an excellent track record of implementation (despite the relatively recent entry of the product into the market), but technical capacity in installing solar in climate resilient design can be improved.

There is also limited capacity of AGRITEX to support communities to integrate climate risk management into institutional arrangements (IMCs), to sustain investments in infrastructure (climate risk-informed O&M) and to support farmers to interpret and use weather and seasonal climate information as part of regular irrigation scheduling activities[304]. The limited capacity of farmers' to incorporate critical climate and weather information, such as rainfall and evapotranspiration, into planning and management of irrigation schemes is significant. Climate resilient informed planning allows the most suitable crops to be planted, tendered and harvested at the optimum times in a season and for scarce water to be used most efficiently to achieve this. Relatedly, there is a need to strengthen the availability of more accurate weather information in specific project areas, as well as introduce training on the use of weather and seasonal climate information as part of regular irrigation scheduling activities. As DoI is primarily involved in irrigation system design (and not continuous and regular management), this training should rather target Irrigation Management Committees (IMCs), with the participation of DOI technicians.

#### 4.2.3.2 Capacity to promote climate resilient agriculture and livelihoods

While national level AGRITEX has a large degree of competence on CRA, capacity building on CRA has not yet been rolled out in the agricultural extension system at scale, complicating the promotion of CRA at national level. This relates to both financial and human resources, e.g. in terms of limited budgets for in-service training and limited public investments into developing and promoting appropriate crop varieties, livestock breeds and CRA practices[305]. A recent update of the AGRITEX extension policy has included insights on resilience from the work of ZRBF, but there is a need to scale out capacity building on resilience and climate change adaptation through in-service training of AGRITEX extension staff. MLAWCCR has collaborated on developing a climate smart manual for agricultural colleges, led by the NGO Green Impact Trust with support from CTCN and others (see Chapter 3), which could be a strategic tool to train agricultural college teachers, students and general extension service on CRA. However, there is no financing for printing and disseminating the manual.

#### 4.2.3.3 Capacity to facilitate market linkages and address climate risks across the value chains

Based on lessons from projects, studies and consultations, the key constraints for smallholder farmers are presented below[306,307].

**Limited capacity of AGRITEX and smallholders to identify market opportunities and respond to market demands:** The extension service has traditionally focused more on agronomic practices than market linkages. While AGRITEX services at district level often include an agro-business unit, there is limited capacity to advice and train small holder farmers in 'farming as a business' and market analysis for climate smart crops and livestock among extension workers in general. In addition AGRITEX officers have expressed limited capacity for dealing with market analysis specific to proposed climate smart crops, in particular sesame and some horticultural crops.
**Limited capacity of AGRITEX Extension Officers to work with key actors in the agriculture sector to facilitate entry into climate resilient markets:** To ensure uptake of climate smart approaches to agricultural crop and livestock production in response to climate change impacts, associated input and output markets are necessary. Smallholder farmers need to be able to purchase drought resilient seeds and climate resilient inputs and sell their crops and livestock in markets. This means it is necessary to address the entire value chain, from planning for climate risk, to ensuring resilience of water and other agricultural inputs, to resilient methods for

[303] Climate Resilient Irrigation sub assessment p.108-111
[304] Climate Resilient Irrigation sub assessment section 2.3.7. During stakeholder conversations, AGRITEX staff at provincial, district and ward level expressed that they have limited knowledge on how to integrate climate risk management in irrigation.
[305] During stakeholder conversations, AGRITEX staff at provincial, district and ward level expressed that they have limited knowledge on how to promote CRA practices, crop varieties and livestock breeds.
[306] Livelihoods and Food Security Programme market study, FAO
[307] CRA validation workshops, June 2017.

production, to, ultimately, linking farmers and their climate resilient agriculture products to markets. However, there is **limited capacity in AGRITEX to employ a comprehensive approach that ensures that climate risks across the value chain are addressed** – and similarly to facilitate the necessary technical, financial and institutional foundations to promote and accelerate climate resilient agricultural value chains that can be viable in the face of climatic changes.

A key barrier to smallholder integration is a lack of platforms where smallholders can voice the climate related risks and challenges they are exposed to, where solutions can be found with stakeholders across the value chain, and where associated markets for climate resilient crops can be grown and strengthened by key market actors. Several value chain studies, including the Value Chain Sub-assessment, indicate that there is significant demand and ready markets for a variety of agricultural products, and great potential for involving smallholder farmers in the production of climate resilient products[308]. However, the **lack of well-functioning market platforms and commodity associations** complicates smallholders entry into conventional as well as climate smart value chains. The agriculture sector has changed in recent years from being dominated by relatively few large commercial farms to being made up by a multitude of smallholder farmers and small, medium and larger sized commercial farms. Smallholders are not well integrated into the formal market infrastructure and support systems.

Other challenges, such as high transportation costs, limited access to climate resilient agro-inputs and drought tolerant seed varieties, and the lack of or weak collective organisation of farmers to capitalise on economies of scale and strengthen their bargaining power, are compounded by this barrier[309].

The increasingly hot weather conditions, as well as the introduction of climate smart crops, requires **investments into value addition**. One of the main challenges in introducing the drought tolerant, climate smart small grains as an alternative to maize, is the labour demanding processing and poor product quality due to inadequate harvesting methods. In order to support effective uptake, **opportunities for value-addition** for small grains also needs to be fully explored through value chain development processes. This may include labour saving, quality enhancing post-harvest processing, storage and marketing technologies and infrastructure[310]. Similarly, other climate resilient value chains may benefit from value adding investments. In horticulture, for instance, increasingly dry and hot conditions increase the demands to product storage, seeing that already up to 30% of horticultural produce in Zimbabwe is lost due to inadequate cold storage.

**Limited capacity to take into account gendered climate risks, gender dimensions of crop and livestock production as well as marketing**[311]. While there has been considerable political commitment and development of strategies to mainstream gender considerations in the agricultural sector at national level, e.g. through the Agriculture Gender Strategy, the Comprehensive Agricultural Policy Framework and ZAIP, this capacity is not yet reflected at scale in extension services, as concluded in the value chain sub assessment. In value chain development, some CSO interventions have focused on gender analysis as part of providing extension services, analysing markets and developing value chains, incl. Technoserve and Scaling Up Adaptation, but knowledge and best practice on gender sensitive market analysis and value chain development initiatives is yet to be scaled out.

**Challenges to access credit and insurance facilities** to procure inputs and other services also inhibit farmers from accessing capital to invest in more efficient production systems, threatening dryland crop-livestock strategies, the sustainability of irrigation schemes and the strengthening of value chains[312,313]. Challenges include unavailability of formal financial services (both geographically and appropriate products), the high cost of finance provided by financial intermediaries, and, arguably most significantly, the credit worthiness of rural smallholders for traditional sources of finance[314]. In the absence of external funding (which in the majority of cases is lacking and if available is expensive[315]) people are forced to rely on their own means. Whilst informal mechanisms initiated and operated by local communities are often not good enough to support climate change adaptation

[308] Technoserve. 2016. SNV value chain studies (2014), ICRISAT diverse studies on goat value chain, Value Chain sub assessment, conversations with private sector stakeholders.
[309] Consultation 6-8 June 2017.
[310] Emerging solutions in small grains value chain in Zimbabwe, 2018, UNDP/ZRBF; Value Chain sub assessment section 3.3.
[311] Value Chain Sub assessment, p. 76
[312] Mombeshora, S. 2003. Water and livelihoods. The case of Tsovani irrigation scheme in Sangwe, Southeastern Zimbabwe. Sustainable livelihoods in Southern Africa: Institutions, Governance and Policy Series, htttp://www.ids.ac.uk.slsa.
[313] Value chain subassessment, p. 68; UNDP GEF Scaling Up Adaptation projet
[314] Recently, development donors have tried to incentivise bank lending to smallholders by focusing on guarantees. However, guarantees have not been sufficient enough to stimulate lending. Banks report that the average risk for smallholder lending is higher than the rest of their lending portfolios, as small holder farmers are more at risk, e.g. during droughts that can undermine their already meagre profits. The lack of reliable insurance or reinsurance products related to climate risks for smallholder farmers also contributes to banks' discomfort with lending to this sector.
[315] The only access to the formal sector involved mobile transfer agents such as Ecocash, Telecash, Nettcash and One wallet. But these tended to be far as were formal banking institutions which had considerably reduced their branch networks.

investments due to their size of lending, village savings and SACCOS are increasingly becoming important in Zimbabwe given the challenges with Banks and MFIs stated above.

Most social safety nets to **mitigate non-climatic and climate change risks** are provided neither by the market nor the state but instead are "informal insurance," arising between individuals and communities on a personalized basis. Although the informal traditional insurance mechanisms have proven to be viable for local communities, they lack the capacity as well as adequate information to enable scale up and wider adoption.

#### *4.2.3.4 Capacity of climate information service providers and end users*

Limited human and technical resources are key barriers to effective provision of climate information services. This is the case in practically all providers involved in the climate information services 'supply chain', namely MSD, ZINWA, AGRITEX and NEWU. These institutions lack adequately trained personnel to manage weather stations, collect weather data (specific to MSD), and collate and analyse information. The institutions also suffer from lack of capacity to continuously train personnel to both upgrade their skills to match improved technology to meet the changing and diverse needs of the end users in the face of climate change. Technical capacity to effectively identify agricultural and water related hazards and forecast their likely impacts on vulnerable communities and agricultural value chains is very specialised and requires a niche skill set, which is currently very weak.

In particular, the capacity to effectively communicate climate information to end users (to interpret and package the information for different users), is lacking. Often information generated is not appropriately translated in a way that communities can usefully receive and apply. Complicated, technical concepts are often used, which are not easily understood by farmers and sometimes not even by extension workers themselves. If farmers do not understand the purpose and benefits of such information, they are likely to ignore it or use it incorrectly, increasing the risk of inappropriate decision-making. Many times, information is also not timely disseminated, compounding the inappropriateness of data if it is also inaptly translated.

Low capacity of service providers is met by limited capacity of end users to interpret and apply the information, as well as limited appreciation of the information. The purpose and benefit of climate and weather products is not widely understood by farmers. Farmers are not involved in the collection of localized information due to an absence of monitoring stations in most instances and also due to lack of technical capacity. They are often not able to use even the simplest equipment, such as rain gauges. However, it must be noted that efforts to establish effective climate information user interface platforms (CIUPs – including use of SMS based technologies), such as those by Practical Action and UNDP/GEF (see section 3.6 and chapter 4), have produced notable indications that CIUPs can be further developed and scaled up for effective delivery of climate and weather information.

*Barriers to implementing downscaled weather forecasts*

In consultations, the Meteorological Services Department noted the following barriers to downscaled weather forecasts.

Limited human capacity: The NWP section has only two people and these should handle all the forecasts and tasks performed on the High Performance Computer (HPC). Adding to their workload in terms of frequency of forecasting and processing data may be unsustainable, especially if one were to leave/quit.

Low computer capacity: The NWP section lacks a high specification computer with high processing power to use in their everyday tasks. This impacts negatively on the time efficiency of their work since low end computers sometimes run slowly when handling high data volumes. The NWP section and MSD lack data storage facilities to archive data processed by HPC. This data is usually high volume data (upwards of 90 gigabytes per each 10 day forecast run) and requires high capacity storage facilities.

Cost of software and modules: Most weather and seasonal forecast models are freely available but processing software e.g. GIS can be costly. Open source software can be used but some commercial software is needed and both models and sotware require their own individual trainings.

# 5 Best practice and lessons learned

This chapter collates best practice and lessons learned from previous and existing efforts to build climate resilient agricultural livelihoods in southern Zimbabwe.

## 5.1 Climate proofing irrigation schemes

### *5.1.1 Climate resilient irrigation design approaches*

The irrigation sub assessment for this feasibility study bases its conclusions on an analysis of previous and existing efforts from a desk study, site visits to 16 irrigation schemes and multiple consultations with stakeholders, including provincial engineers, AGRITEX Extension Officers and farming communities.

The irrigation sub assessment provided an overview of the baseline site information to be considered when designing new irrigation schemes and revitalizing existing schemes in southern Zimbabwe. The historical performances and lessons learned of existing irrigation schemes have also been considered to ensure that the shortcomings that led to unsatisfactory scheme performance are adequately addressed. The sub assessment finds that a climate resilient, 'revitalisation' design approach to new and existing irrigation schemes overcomes challenges faced by previous irrigation investments to sustainably increase reliability and assurance of water supply for smallholders in the face of increasing climate risks.

Irrigation schemes are highly case-specific and the diverse conditions of each scheme (climate, water and soil conditions, technology, scheme and plot size, farmer profile, location and access to markets and services) calls for different kinds of climate proofing design interventions to respond to farmers' needs. The sub assessment concluded that adequate infrastructure designs, which are responsive to the changing climatic conditions is key to success of new schemes and the revitalisation of existing schemes should integrate climate proofing measures. The changing climate may also mean that currently functional existing infrastructure is compromised, forcing earlier investment and lower returns for existing investment.

Based on the irrigation sub assessment analysis of the various schemes, it was concluded that:

- While flood irrigation is currently the most used technology, flood irrigation was not effective in the increasingly water scarce environments of southern Zimbabwe. Water use efficiency through sprinkler or drip irrigation was confirmed to be more effective and feasible for smallholder irrigation schemes.
- At many of the visited sites, it was evident that much of the infrastructure damage and deterioration was due to flooding, while siltation was prevalent in reducing dam storages.

Best practice in designing climate resilient irrigation, predominantly from the practical experience of CRIDF's pilot projects[316], entails the following:

- **Hydrological assessments** to determine the flow and intra- and inter-annual variation of water resources over time, accounting for projected climate variability and change for water users, in technical engineering design. These determine water adequacy and inform the 'type' of infrastructure needed to provide an acceptable supply assurance, such as whether there is a need to build a small dam or weir.
- **Flood forecasting** – actual flood records and those that are obtained from the analysis of hydrological data to determine pumping station requirements and location and the selection of irrigation technologies. Current practice is to site pumps as near to river banks as possible, often in flood zones, without an assessment of the probability of flooding and with no protection against flood damage.
- Appropriate **irrigation technologies** that increase water efficiency – flood irrigation technology, currently prevalent in schemes, has high losses due to evapotranspiration and seepage, which are not conducive to efficient water storage or usage compared to other technologies, such as drip, centre pivots and sprinkler systems. These however, need to be suited to context.
- A **Climate Change Risk Assessment** (CCRA)[317] tool – conducted to support the development of technical engineering designs to ensure projects are resilient to climate change impacts, as well the ability of the infrastructure to continue to provide climate resilience to the surrounding communities in the long-term.

[316] Cf. Climate resilient irrigation sub assessment, section 3.5.
[317] CRIDF. 2016. Climate Change Risk Assessment. Available on: https://www.cridf.com/ccra (Accessed 5 May 2017)

- A **Financial and Economic Cost Benefit Analysis Tool**[318] – conducted to support both the engineering design choices for the economic rationale and viability considerations to ensure sustainability and good use of funding.
-

While it is not possible to mitigate the frequency or duration of flooding, climate proofing techniques that protect the irrigation and related infrastructure should be employed. Methods of climate proofing infrastructure against floods include[319]:

- **River or watercourse bank reinforcement** that involves adding material to the bank face to increase the bank stability and protection from river scour and erosion. These designs should withstand hydrostatic forces as well as floods.
- **Bioengineering** that refers to the use of plants or planting to stabilize the bank and increase the ability to resist erosion, scour by river and flood flows.
- **Gabions** that are wire-mesh baskets filled with locally available stones in block or mattress (flat) form. They can be stacked to form a stepped wall or can be laid on gentler slopes to form a surface covering for scour protection. The blocks are interlaced to form a flexible surface that resists erosive flood forces.
- **Riprap/Geotextile** which is an exposed layer of well graded stone or rock placed on a sloping bank face to resist erosive flood waters. A synthetic geotextile is usually placed between the riprap and underlying soil to act as a filter, thereby preventing the piping of soil through the rock and relieving hydrostatic pressure used to provide long term protection.
- **Structure anchoring** where the structure is pinned and tied to a sound foundation to resist collapse and movement from hydro forces and scour.
- Installation of **watertight closures** which stops migration of water from one side to the other and to keep chambers dry.
- **Usage of sealants** to reduces seepage through walls.
- **Installation of check valves** to prevent the backflow entrance of floodwater flows into utilities in a structure like a pump house or power station.
- **Above flood level location** of electrical, mechanical, and other equipment and contents will stop the equipment from being flooded.
- **Diversions and rerouting** of existing water course channel to divert excess storm water flow reduces flood risk and protects structures.

[318] CRIDF. 2016. Financial & Economic Appraisal Process. Available on: https://www.cridf.com/cba (Accessed 5 May 2017).
[319] Cf. Irrigation Sub assessment, p. 91-93

Box 1: Case study: importance of 'climate-proofed' design: Shashe irrigation scheme project in Manicaland

The importance of design which 'climate proofs' irrigation infrastructure is reflected in the experience of the Shashe irrigation scheme project (in Manicaland Province). Funded by UNDP/GEF and implemented by Safire, the project has made significant progress in providing irrigation for 450ha in Manicaland province (AER IV and V). A weir has been built and AGRITEX and DoI provide support for infrastructure upkeep and agronomic practices. However, every year, with the occurrence of just one storm, the 8km distribution canal (which conveys water from the water source to farmers' fields), is silted, preventing irrigation from taking place. Flooding in the region is seen to be increasing, as well as the occurrence of extreme flooding events, such as the severe flash flood that hit the Shashe scheme on the night of 26th December 2014. Rainfall received amounted to 70mm, which is considered extreme relative to the area (the previous recorded highest rainfall was 50mm in 2013). Siltation is also attributed in part to unsustainable farming practices, such as stream-bed cultivation and deforestation. Save catchment in particular is affected by siltation. Each time there is a flooding event, the 8km distribution canal is desilted by renting government owned mechanical equipment for $200 per hour, an activity that is expensive and unsustainable.

Source: Safire. 2015. Shashe Irrigation Scheme Post Flooding Disaster Assessment Report. Safire. Interview with Safire Project Manager, March 2017.

In addition to the above mentioned methods, technologies such as sand abstraction and sand dams have been successfully implemented in Matabeleland by the Dabane Trust and partners and should also be considered, where appropriate[320].

### *5.1.2 Sustainability: climate resilient operation and maintenance of irrigation schemes*

Several interventions provide institutional capacity building for communities on irrigation schemes as a component of support to safeguard investments in irrigation infrastructure and to ultimately increase communities' agricultural production so that communities may effectively sustain schemes beyond project support. This support is targeted primarily at training communities in operation and maintenance (O&M) and collective organisation regarding cropping patterns and marketing, through the strengthening of Irrigation Management Committees (IMCs). Support is also often provided to government service providers, such as AGRITEX, to train Extension Officers to support farmers to utilise schemes. The EU/Cesvi project with the farming community of Maramani Communal Land in Beitbridge (AER V) on the Shashe irrigation scheme presents an example of successful management arrangements to introduce high-value, climate resilient irrigated crops (see box 2, below).

The basic premise for O&M sustainability on communal irrigation schemes is held in the assumption that incomes from increased agricultural production will allow communities to meet O&M costs required. For example, the evaluation report of the FAO's Market and Agri-Services Linkages Component of the Smallholder Irrigation Support Project (see Chapter 3) states that: 'financial sustainability will be ensured if there is viable production and marketing of produce which will enable the famers to contribute a certain percentage of their crop revenue towards operation and maintenance costs of the scheme, provision of scheme levels services such as technical advice, market assessments, post-harvest facilities, and marketing of produce'[321]. However, practical experience from other efforts, principally CRIDF's pilot projects, indicates that due to the nature of the type of water provision projects concerned, and the lack of communities' capacities to be able to generate revenue at the project outset, a rigorous financial and economic assessment – a Cost Benefit Analysis or similar – should be conducted, as financial and economic *viability* in the approach to irrigation design is also a crucial component to achieve sustainability and determine the necessary O&M costs.

[320] Conversation with J. Reeves, DFID, 2.Aug.2018

[321] FAO. 2010. Mid-term Evaluation of the Smallholder Micro-Irrigation Development Support Programme (SMIDSP) Report on the Market and Agri-Services Linkage Component. FAO.

Box 2: Case study: Shashe irrigation scheme management model (Beitbridge, Matabeleland South Province)

The farming community of Maramani Communal Land in Beitbridge (AER V) is introducing high value, long-term (citrus) and seasonal (grain and vegetables) crops through irrigation, where management arrangements are integral to the project's approach. The project, funded by EU and implemented by CESVI, involves a number of elements, including installation of more efficient irrigation technology, crop diversification, strengthened market linkages and institutional capacity building. The following management conditions are recommended:

- Devolution of 'ownership' to beneficiary farmers as much as possible, who form a management organisation with constituent representation;
- Considerable institutional development, the acquisition of skills and additional competencies sufficient to manage the complexities of a commercial enterprise;
- Creation of partnerships with the private sector, focused upon seeking market guarantees, crop loan finance and technical support for economically profitable crops to be grown in preference or addition to crops grown for food security;
- Support from extension agencies (NGOs, local and central government and private) to assist farmers to make the transition to one of commercial sustainability with a food security element.

Source: Latham, C. J. K. et al. 2015. From subsistence agriculture to commercial enterprise: community management of green technologies for resilient food production. Future of Food: Journal on Food, Agriculture and Society 3(2), pp.8-17.

CBA is a methodology that involves weighing up the implicit and explicit positive and negative impacts (costs and benefits) of a project, in terms of its contribution to social welfare. Given that profit is not always the primary objective, CBA serves to indicate whether there is an economic rationale for the public provision of a good/service (the project) – i.e. because it will generate a positive net social benefit – even when a project may not necessarily be financially profitable. Based on the financial and economic analyses, the necessary O&M costs are generated to ensure sustainability. CRIDF best practice shows that O&M costs should be factored into the budget for the first two years of the project, to allow time for IMCs to put appropriate measures in place to eventually fulfil their upkeep responsibilities and operation capacities to manage climate risk (see case study, below). This highlights the importance of climate resilient irrigation design as a sustainable approach to increasing water security, as well as in terms of financial sustainability per se.

Best practice from CRIDF to support communities to uptake responsibilities for O&M shows that one way of doing this is to support IMCs to develop a communally owned scheme 'Constitution'. This is an appropriate and accepted 'set of rules', which every member of the scheme is expected to sigh, to build a set of expectations that community members are expected to adhere to and the benefits they can expect to receive in return. This supports IMCs to manage individual participation in the collective maintenance of communally used irrigation infrastructure A key part of the scheme Constitution, as is the case in CRIDF's pilot projects, is a 'Maintenance Fund', which each member benefiting from the scheme is expected to contribute to on a monthly basis. While project budgets should build in costs to provide an initial buffer for this fund (as part of the O&M budget line), over time, community contributions, made possible by increased incomes from increased yields, will generate enough capital to pay for the upkeep of the irrigation infrastructure, including paying engineers to fix problems, repairing faulty equipment etc. Sustainability considerations also include training and capacity building of service providers such as DoI, ZINWA and AGRITEX (see sections below).

Box 3: Case study: CRIDF's Kufandada Cost Benefit Analysis

The budget for CRIDF's pilot project in Kufandada is structured based on a Cost Benefit Analysis (CBA), which assesses the financial and economic viability of the project intervention.
For a project of this nature, it is unlikely that it will be financially viable on a standalone basis; however, should the economic and social rationale for the project be clearly demonstrated, external financial support for the project can be justified. The CBA is conducted from the perspective of the local communities. They will become the effective owners of the infrastructure - accruing direct benefits through agricultural use, whilst also being responsible for its operation and maintenance costs in the medium and long term. As it is a rural water supply project, the communities will not be charged water

tariffs but will instead need to generate costs to cover the on-going operation and maintenance of the project.

The CBA results necessitate a budget consisting of capex grant financing, both upfront for design and installation of irrigation infrastructure, and for two years after installation in O&M, to support the initial start-up of revenue-funded O&M by the community. O&M costs covered in the first two years by the project budget allows Irrigation Management Committees (IMCs) time to build resources for O&M. Following this time period, O&M costs are covered by funds collected in a 'Maintenance Fund', which all members of the community who benefit from the scheme contribute to on a monthly basis from the start of the project, and/or is deducted from revenues (as stated in the scheme Constitution). Over time, this should provide enough funds to pay for equipment repairs and technicians. Profits generated from surplus production from the first season would also be included in the 'Maintenance Fund' as an initial buffer, to encourage the concept of investing back into the next season, through buying inputs, technology and fertilisers etc.

Source: CRIDF. 2014. Kufandada Irrigation Scheme Economic & Financial Analysis. CRIDF.

### *5.1.3 Solar power on small-scale, rural, climate resilient irrigation schemes*

While very **few interventions have installed solar power on irrigation schemes, they have been successful in highlighting the potential solar has to overcoming energy barriers facing irrigation schemes** (due to unreliable grid supply), as well as reducing energy and O&M costs (in comparison to diesel, for example). Solar power also provides mitigation co-benefits. According to a survey of 16 irrigation schemes across the southern provinces conducted for the Climate Resilient Irrigation Sub-assessment, which are predominantly powered by grid or diesel power sources; many experience viability problems, largely attributable to physical infrastructure inadequacies and operation of the power source[322]. Diesel powered schemes also have high associated O&M costs. One of the key problems identified for those with access to grid power, is that of erratic, unreliable supply due to the national power supply deficit, line breakdowns and power outages. Unreliable supply results in poor irrigation scheduling, which leads to poor yields and uneconomic returns. This cycle leads to farmers' inability to service O&M bills, which in some instances has resulted in disconnections from the grid due to power debts.

The Ruti irrigation scheme in Gutu, an Oxfam implemented project funded by DFID, has installed solar irrigation pumps to irrigate 20ha of land to benefit 92 households, helping them to increase agricultural productivity and adapt to the effects of climate change (see Chapter 3). Implemented in August 2015, it is still too early to judge the success of this project. This is also the case for the 99 kW Mashaba mini-grid in Gwanda, established in 2015/16, and from the CRIDF intervention, although initial findings from the CRIDF experience highlight that IMCs are able to successfully operate solar panels to meet their pumping requirements, overcoming energy barriers. As highlighted by the Solar PV Viability Analysis Sub-assessment, training and capacity building of communities to operate and maintain the solar component within irrigation schemes is crucial for successful utilisation of solar and its sustainability.

## 5.2 Promoting climate smart agricultural livelihoods

### *5.2.1 Build on efforts in Conservation Agriculture adoption to support Climate-Smart Agriculture up-scaling*

In recent years, MLAWCCR, with support from FAO and EU, has worked to increase smallholders' adoption of CA and CRA practices (see Chapter 3). Lessons learned from promoting CA practices are useful when **designing effective models for extension services and other support to farmers to support CRA up-scaling, and there is good potential to draw on the CA network of the CA Taskforce in promoting CRA practices**. When CA was introduced, the uptake was relatively slow, as farmers were unwilling to convert all of their land to CA practices. FAO notes that one of the reasons for this may be that in its initial stages, CA is more labour-intensive than conventional methods[323]. However, once farmers passed the initial labour intensive, start-up seasons, CA techniques cut down on waste of inputs, reduce their costs and improved the yields significantly. Efforts to encourage sustained engagement of farmers, and providing incentives for them to continue to apply CRA techniques may result in greater levels of adoption. FAO promoted CA methods through programmes of training and demonstrations, and introduction of labour saving equipment to win over farmers. As a result, more farmers adhered to the techniques, and other farmers who had seen gains on their neighbours' farms made the decision to adopt CA. In 2011, it was estimated that the number of smallholders practising some form of CA in Zimbabwe

[322] Visits conducted as part of the Climate Resilient Irrigation Sub-assessment methodology.
[323] FAO. 2013. Conservation agriculture contributes to Zimbabwe economic recovery. Available on: http://www.fao.org/in-action/conservation-agriculture-contributes-to-zimbabwe-economic-recovery/en/ (Accessed 5 May 2017)

increased from 5,000 in 2005, to more than 150,000 in 2010, with recorded cereal yield gains of between 15-100% across AERs[324,325].

Also, CA has been promoted by the CA Taskforce through a manual on CA: Farming for the Future[326]. The manual is a practical guide to CA and has been used to educate and support AGRITEX Officers to promote CA practices. The CRA Manual for Zimbabwe by MLAWCCR also includes and expands on CA practices (as mentioned in Chapter 3). Best practice that the manual captures from specific, practical Zimbabwe experiences should be built on and implemented in CRA upscaling in this project.

### *5.2.2 Farmer Field Schools and demonstration plots*

Farmer Field Schools are a tried and tested methodology in Zimbabwe to support farmers to increase their crop and livestock and irrigated production systems. The FFS methodology was successfully used by MLAWCCR, FAO and the CA task force to promote CA in Zimbabwe. Lessons learned from UNDP's Scaling Up Adaptation project shows that FFS's have been highly successful as a collaborative learning space for lead farmers, as well as an inspiration to their communities.

Experience from UNDP projects and ZRBF MELANA project, implemented by the WHH consortium, reveals that building the capacity of farmers to diversify into climate resilient crop production through supporting **farmer-managed demonstrations** for trying a **variety of adaptation measures** is important and has shown successful results. There is merit in exposing farmers to as many options as possible. In the project, farmers have been exposed to a range of climate smart cropping options. Farmer managed demonstrations are the best way to do this, since these will make it possible to answer important evaluation questions on: what works, why and under what circumstances. Such information will be particularly relevant for upscaling promising adaptation strategies. The pilot demonstration crop projects also clearly show the importance of **farmer managed trials**, since it was possible to screen technologies that will not be easily adopted by farmers because of farmers' constraining circumstances. Under MELANA, trying out different processing technologies (using polythene sheets, mud ground or plastic buckets) for sesame processing allowed both resource poor and resource endowed farmers to select what was suitable for their context.

Box 4:Farmer Field Schools: features and implementation approaches

Farmer Field Schools take a starting point in participatory adult pedagogy and the experience that farmers learn more from other farmers, working side by side, rather than from outsiders with a top down approach. It is easier for farmers to mirror themselves in another farmer, trust each other's experience and explain the methodologies in a way that makes sense to them in a particular context. This is based on a recognition that farmers have valuable knowledge and experience that needs to be put into play and work together with extension services – a two-way extension approach. Ideally, lead farmers should be both men and women, young and old, so that their experiences are relevant to a wide range of households in a given community. Whatever system is chosen, it is key to make sure that all stakeholders clearly understand the process and that a relationship of trust is built with the community before and during implementation.

Farmer Field Schools have been used as part of promoting CA through several modalities in Zimbabwe. The below examples are taken from the CA manual Farming for the Future, developed by the CA Taskforce:

- Extension Agent system: Trained extension staff work with groups or clusters of farmers to support them in implementing CA on their own fields
- Lead Farmer system: Trained extension staff work with a group of lead farmers in a community, who in turn promote the CA methodologies to other farmers in the community. In order to create the most successful cascading of experience and skills, lead farmers should successfully have been practising CA for at least two seasons and should be individuals who are trusted by other farmers.
- Combined Extension Agent and Lead Farmer system: In some cases, organizations start by working with farmer groups, before they select the lead farmers who will continue to extend the method in the future.

324 Marongwe L.S. et al. 2011. An African Success: The Case of Conservation Agriculture in Zimbabwe, International Journal of Agricultural Sustainability, 9, pp. 153-161.
325 ICRISAT. 2013. Conservation agriculture and micro-dosing in Zimbabwe. Available on: https://www.ard-europe.org/fileadmin/SITE_MASTER/content/eiard/Documents/Impact_case_studies_2013/ICRISAT_-_ (Accessed 5 May 2017)
326 Zimbabwe Conservation Agriculture Task Force. 2009. Farming for the Future: A Guide to Conservation Agriculture in Zimbabwe. Christian Aid and FAO Zimbabwe.

The FFS are based on participatory adult learning/extension principles and aim to be as participatory and practical as possible to support learning. This process often entails the following elements:

- Establishment and preparation of a learning plot. This enables farmers to have a practical space for learning, as well as to go and put into practice what they have learned on their own plots.
- The CA package will be fully implemented on one part of the plot, and conventional methods will be showcased for easy comparison on the other part.
- Farmers meet regularly to learn and discuss, when there is something new to learn or observe during a season. This is often 5-6 times with key events being land preparation, planting, monitoring of crops, flowering, harvest. The condition of the crops and field dictates meeting periodicity and the learning topics, as training is done as a result of practical experimentation and dialogue in the field.

Other learning methods that can supplement the FFS are:

- Research collaboration with external resource persons e.g. DR&SS in terms of testing particular improved varieties or methods
- Field days – where the community and visiting farmers may come to experience the effectiveness of a particular agricultural crop/practice, share experiences and be inspired to try out practices on their own plots
- Farmer to farmer exchange: Projects may consider different type of peer knowledge and experience exchange, as most farmers learn well from their peers.

Source: Zimbabwe Conservation Agriculture Task Force. 2009. Farming for the Future: A Guide to Conservation Agriculture in Zimbabwe. Christian Aid and FAO Zimbabwe.

### *5.2.3 Innovation Platforms as a tool to facilitate learning and action among stakeholders*

During the CRA package validation sessions in June 2017, AGRITEX staff at national, provincial and district levels expressed interest and support for upscaling the use of Innovation Platforms to build a strong knowledge base on climate-smart agriculture, implement adaptive management practices in agriculture and facilitate market linkages for climate-smart crops and livestock, with a focus on smallholder farmers. It was suggested that a combination of Farmer Field Schools and Innovation Platforms would be effective and provide a sustainable impact in terms of identifying challenges and gathering experience on promotion of CRA through FFS's, and developing CRA approaches[327]. These experiences should then be up-scaled into policy and national level institutional capacity building and out-scaled through public and private extension services.

The example of an Innovation Platform for exploring challenges around food and nutrition security, adoption of high-nutrient bean varieties, and value chain development in Chimanimani, Manicaland in Zimbabwe, demonstrates how an Innovation Platform may work to support market linkages and the usefulness of Innovation Platforms as a space for learning and action around new agricultural practices and behaviour change. Through collective development of possible solutions and stakeholder commitment, the platform supported positive change in yield levels and income levels. The increase in income among participating farmers contributed to the adoption of the demonstrated practices and varieties by surrounding communities (see Box 9 in Section 5.3, below). Also, in the case of an ICRISAT facilitated platform on the livestock value chain in Gwanda, the Innovation Platform helped stakeholders to find shared solutions to the bottlenecks and constraints in the goat value chain, by developing feedlots, auction spaces and improving livestock management practices (see Box 10 in Section 5.3, below).

Box 5: Lessons learned on facilitation and institutional management of Innovation Platforms

Lessons learned from ICRISAT in Zimbabwe suggest that Innovation Platforms have been most successful and cost effective, when a few, strategic Innovation Platforms have been implemented very well, rather than putting the Innovation Platform to use at scale. This has allowed for innovations, experience and impacts to be scaled up and out to larger areas. ICRISAT has successfully established Innovation Platforms at district level, from where the institution has trained and linked AGRITEX Extension Officers with farmer groups and private sector players. The experiences and tested methodologies from one district have then been

[327] May 2, 2017, CRA consultations with national level stakeholders.

scaled out to reach other districts.

ICRISAT notes that it is important to have strong facilitation in place to create the momentum that will pull in participation from farmers, private sector and other stakeholders. At the level of smallholder farmers, ICRISAT notes that active and sustained participation happens because of farmers' interests in the theme of the Innovation Platform and because they see the concrete benefits and impacts from improved markets rewarding their Innovation Platform engagements. Keeping all players engaged and motivated requires a significant investment in facilitation during the initial phase, and ideally this role will be taken over by key stakeholders during the course of the development of Innovation Platforms, to encourage sustainability.

Where there was continued interest for developing the value chain, local stakeholders have taken over the running of the platform after the project lifecycle ended. This has been the case of ICRISAT facilitated platforms in Gwanda, Insiza and Matobo, where some Rural District Councils decided to take over the running of platforms when the project funding ended. For this project, it is recommended to use DR&SS research stations and AGRITEX Agricultural Training Colleges as hosts or hubs for the learning and innovation surrounding Innovation Platforms to institutionalise the process of climate smart, adaptive management in agricultural practice and training.

Source: ICRISAT. 2013. Seven lessons learned to catalyse African innovation through engagement platforms. CGIAR.

## 5.3 Smallholder climate resilient commercialisation: linking farmers to markets

### *5.3.1 Climate risk-informed market analysis for climate smart production*

As CRA practices are introduced among smallholder farmers to increase climate resilient agriculture production, it is important to ensure that there are ready markets for farmers to sell their produce, both in terms of informing crop-livestock production choices and to provide incentives to encourage farmers to adopt and diversify into new practices and livelihood strategies. Such an approach should analyse climate risks across the value chain. There has been limited government and donor investment in smallholder commercialisation, although recent years has shown an increased interest and recognition of the importance of private sector engagement and market driven approaches to support smallholders in developing agricultural livelihoods. Several recent project experiences and the Value Chain Sub-assessment findings support that sustained development impacts in smallholder commercialisation are most likely to be achieved through an approach that works with and is often driven by the private sector.

A key learning from pilot interventions in the Coping with Drought project (2008-2012) was the need to address climate change vulnerabilities in a multidimensional, yet focused way. This learning was carried over to the Scaling up Adaptation project (2014-2018), which has succeeded in bridging smallholders' agricultural production , market opportunities and demands, and options for building climate resilience. The project has demonstrated that if smallholders are able to minimize climate risks to agricultural production, produce high quality products and effectively link up to markets, they have a greater chance of lifting themselves out of poverty and towards profitable livelihoods and establishing micro-enterprises[328]. This links well with lessons learned across several projects, including CRIDF's pilot projects' practical experience, that support to agricultural production needs to be coupled with market linkage support (see Chapter 3).

Such lessons point to the need to analyse the three components of: 1. smallholder production capabilities, regarding capacities required to adopt climate resilient agriculture and suitable crops/livestock given ecological conditions (now and with projected changes in climate), 2. market opportunities and demands, and 3. options for climate resilient value chain development through the development of market linkages (see Figure 29, below). Such an analysis was undertaken by the Value Chain Sub-assessment, which mapped out climate smart crop-livestock combinations with high impact potential for smallholders, indicated by criteria such as a documented, ready market, climate resilient potential, potential for decreasing poverty and food insecurity, and potential for establishing market linkages with key market actors in identified value chains. The findings identified the horticulture, sesame, small grains and sorghum and livestock value chains as having the greatest potential according to such criteria (see justification in Table 13).

[328] Terminal evaluation, 2019, Scaling Up Adaptation

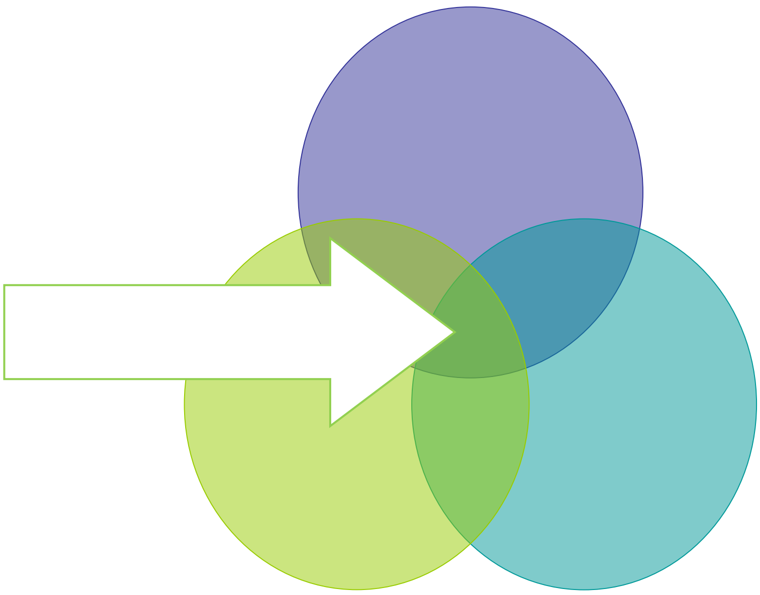


Figure 29: Climate resilient market analysis

Table 13: Choice of climate resilient value chains

| Proposed Value chains | Justification |
|---|---|
| **Irrigated horticulture**<br>- Irrigation schemes | Irrigation removes the risk of rain failure during the rainy season and allows for cultivation in dry season. High profitability, depending on horticultural product. The horticultural products were selected based on **commercial potential** with criteria such as high value per hectare, existing production skills, low perishability, well defined markets and formal and informal unmet market demand. The study also concluded that there is **scope to expand and complement** these products as variety is one of the key competitive advantages mentioned by buyers. Research expertise in Zimbabwe. |
| **Sesame**<br>- Dry land farmers | New crop, but well suited to Zimbabwean climate and agricultural systems. Drought tolerant and grows under rain fed farming. Low cost of inputs with a good rate of return. High potential. Formal market and unmet demand identified. |
| **Small grains**<br>- Dry land farmers | Drought resistant alternative to maize. The most reliable cropping option for food security and good nutrition value. Low cost in terms of input. Potential for diverse value addition. While mainly contributing to food and nutrition security, the crop also holds commercial formal and informal potential. Research expertise in Zimbabwe. |
| **Livestock**<br>– Cross cutting. In combination with other dryland farming. | Critical element of farming systems in the three provinces and of socio-cultural high priority. High level of livestock management knowledge, livestock research expertise and some value chain infrastructure present. High potential to develop the value chain further. |

### *5.3.2 Linking climate resilient production to markets: contract farming*

In investigating ways of introducing new climate smart crop and livestock combinations to smallholders, the Value Chain Sub-assessment identified facilitating links to off-takers in **contract farming arrangements** as a strategic option for integrating smallholders into markets as an incentive to adopt CRA practices[329]. There is an increasing number of companies engaging in contract farming and through consultations and interviews with agribusinesses, the Value Chain Sub-assessment documents that there is appetite from private sector actors to work with smallholders to meet gaps in formal markets (see Box 6 and 7, below), reinforcing these findings. Contract farming efforts have predominantly focused on crop production and in particular the irrigated horticulture value chain, as horticulture crops offer a higher return per hectare relative to other crops (see Value Chain Sub-assessment and Chapter 1). The formal domestic market provides the greatest opportunity for smallholders in the case of irrigated horticulture, in terms of profitability, a guaranteed market and long-term sustainability.

Aligning production to market trends through contract farming arrangements provides farmers with a guaranteed market to sell their produce and reduces production barriers to entry to formal markets that exclude smallholders, including quality, price, reliability of supply, transport links, storage requirements etc. These present barriers for women farmers in particular, as women disproportionately lack access to resources compared to men[330]. In this sense, contract farming works well with the company, or the 'anchor', taking the financial responsibility for providing inputs, usually supported by NGOs. Contract farming arrangements are predicted to reduce the rate of failure of schemes, as training and inputs are provided, and a track record of production success, overtime, increases trust between smallholders and private companies. Farmers' organisation based around schemes could also lead to formulation of commodity groups or farmers associations, which would also increase their negotiating power and resources in the long-term. Contract or collective marketing can also increase women's participation in formal markets, as they do not need to travel far from the farm. Further, market linkage models that promote central and specialised management of production can benefit women who are often excluded from training and information services.

Box 6: Different pathways to market

Smallholder irrigators growing horticulture have three pathways to market. The bulk of produce (fruit, vegetables and flowers) is bought on farm by aggregators or middlemen (roughly estimated at 60% by farmers), servicing mainly municipal markets and some shops. A small proportion of farmers (not specified), whose schemes are closer to town, take produce to these markets on their own. However, women farmers during interviews reported their preference of selling produce closer to the farm, rather than travelling to town, due to time constraints and unsafe accommodation. A third category is under contract farming with companies such as Matanuska (banana), MFCCC (seed maize), Seedco (sugar beans), Best Fruit Processors (butternut, tomato and citrus), Cairns (navy beans and tomato) etc. Local sales to dryland famers are insignificant but persistent (included in 15% local sales to mainly local traders), and usually done in exchange for dryland crops or labour.

Source: Value Chain Sub-assessment

[329] This approach was also effectively used by the UNDP/GEF project Scaling up Adaptation with a Focus on Rural Liveilhoods
[330] Gender annex and Value chain assessment

Box 7:Lessons learned from contract farming

Key lessons from interventions supporting smallholders to secure and implement contract farming arrangements include:

- Lessons from contract farming in the oilseeds subsector under the SNV's RARP revealed that contract farming operation requires significant start-up costs and a long-term view in order to achieve economies of scale. Private companies must be willing to invest in smallholders' capacity building. Providing a base price helps to cushion against price volatility. This should not prevent influence of prevailing market price. Demonstration plots, trials, field days, exchange and exposure visits are vital for behaviour change and uptake of standard.
- Lessons emerging from the USAID supported Amalima and ENSURE projects indicate that targeting households which are too poor or with weak capacity presents challenges in building sustainable capacity for production or micro entrepreneurship. Proper targeting is therefore important and often using community champions for change such as lead farmers has been the recommended strategy.
- Facilitating aggregation is a recommended strategy for building capacity for achieving economies of scale for smallholders as shown in the UNDP/GEF Scaling Up Adaptation project[331]. Establishment of commodity associations at ward level for production and primary processing where possible add value. Collaboration through commodity specific groups helps to increase production and efficient marketing and stronger bargaining power. Commodity associations should be organically formed by farmers in close proximity and on contiguous fields.
- Building capacities of rural smallholders for enterprise growth and development often involves packages for subsidised inputs and services. Whilst this is a good strategy for achieving food security, it may be detrimental to sustained growth where funds flows are interrupted and it often crowds out private sector. Interventions should seek to ensure that external support and efforts are targeted effectively such that they also stimulate private sector innovation and engagement, avoid crowding private players out and distorting markets.
- An important lesson learned from the experience of Matanuska, the country's top banana producer, which has been undertaking contract farming with smallholders in recent years, it that expectations need to be managed carefully from the outset on both the part of the company and smallholders. Farmers expressed dissatisfaction that they had been promised one price per ton for bananas at the start of a season and given a lower price at the end of the season[332]. However, it is often not uncommon for agribusinesses to indicatively suggest a price at the beginning of the season, only for the market prices to decrease, and they pay less than the indicative price at the time of purchase. Development partners and AGRITEX may therefore have a role to play in ensuring the conditions and expectations of the arrangement are understood by all parties. This points to the barrier that there is little legal support provided to smallholders when negotiating contracts: often farmers don't understand the contract terms and both companies and farmers have been seen to default on the contract agreements.
- The ability of communities to articulate a vision to collectively organise themselves is crucial to the success of contract farming interventions. A common standpoint increases their negotiating power and ability to pool resources. While issues concerning self-organisation were sited in interviews, such as group conflicts and lack of knowledge on where to market bulk production, this perhaps points to the need for strong management of production operations. One way of doing this, as identified by the Maramani community's experience, could be to designate a professional 'project manager' to oversee production and improve efficiency of operations. This would allocate responsibility to an individual to work with the community, AGRITEX and other stakeholders to identify market trends to drive production and support crop knowledge provision, which should go some way to preventing group conflicts.

While best practice indicates that contract farming has high potential mechanism to link smallholders to the formal domestic market, which offers the greatest opportunity in terms of highest value, the informal market allows thousands of farmers potential entry into horticulture due to lower barriers of entry. Data collected by eMkambo for April 2015 at Mbare, the biggest municipal market in Zimbabwe, showed that a total of 2,022 tons of horticulture produce was traded in that month, with earned value of above US$1.4M[333], demonstrating the value these markets can have. It is also important to note that targeting supply to municipal markets offers more

331 Scaling Up Adaptation with a focus on Rural Livelihoods, terminal evalutation, 2019
332 CRA Package Sub-assessment, stakeholder consultations, May 2017.
333 eMKambo. 2015. Of packaging and units of agricultural trade. Available on: https://emkambo.wordpress.com/2015/04/ (Accessed 5 May 2017)

opportunities to urban women traders as they dominate these markets. For example, at Chitima market (Masvingo), 75% of the 300 agriculture traders are women[334]. This implies that a strategic, two-pronged approach may be appropriate, targeting both markets at the same time.

Currently for small grains, most farmers grow for home consumption or bring the produce to the informal market for sale to aggregators or middlemen, who transport the grain to larger markets. There are also promising examples of farmers growing sorghum on contract for Delta Breweries. Smallholders livestock is often bought by middlemen at the farm gate, and due to a limited number of buying agents active in any village market at any one time, the buyer has significant market power in setting an often very low buying price. The Value Chain Sub-assessment highlighted that adequate marketing infrastructure and improved market linkages may contribute to higher prices for farmers. The sesame value chain currently has the biggest income generation potential in contract farming arrangements, namely with Sidella and IETC[335].

Intermediary arrangements also present an opportunity to initiate market links and may work well for farmers in very remote locations as a first step to entering the domestic formal market. For example, Best Fruit Processors uses an intermediate contract farming model by sourcing butternuts from farmers in southern Zimbabwe through an agent called Masvingo Food Commodities Cooperative Company (MFCC).

Additionally, while 'middlemen' have a reputation for hoarding produce from smallholders at very low cost and selling at considerably higher prices, depriving farmers of potentially higher incomes, the removal of middlemen would not necessarily remove the barriers smallholders face in marketing horticulture: too much produce at a given time, lack of proper storage facilities, transporting challenges, remoteness, poor road network and lack of adequate time for selling results in farmers relying on middlemen as buyers of last resort. As long as these barriers are not resolved, middlemen still have a role to play in horticulture value chain. As such, there is need for interventions that support the engagement of middlemen with farmers to ensure win-win partnerships.

Additionally, the Value Chain Sub-assessment recommended that **value addition** of products should be prioritised to support farmer's access to markets and improved income[336]. While consultations pointed to little potential for adding significant value through small scale processing of horticultural products, small grains production and sales would benefit from local level processing facilities for milling. For horticultural products, the main value addition at the level of smallholders is in storage facilities. A large percentage of horticultural produce in Zimbabwe is lost due to inadequate storage facilities. A basic storage shed for products like butternut or cold storage for perishable products would increase the amount of produce that reaches the market in good quality. This in turn requires adequate transport facilities, but here private sector players have indicated willingness to provide transport, given that adequate quality and quantity of produce. For livestock, value addition may be as simple as marketing facilities, such as fattening and auctioning pens to fetch better prices for the animals.

Box 8: Contract farming case studies and lessons learned

Best Fruit Processors (BFP), a processor of fruit and vegetables (juices and purees) located in Norton near Harare, has 3,000 smallholder suppliers of tomato and butternut. In interviews during Feasibility Stage, the company commented on how successful such arrangements are. The company stated that arrangements are usually made with collective farmers, or farmer groups, who farm collectively at least 20ha. This is predominantly facilitated with support from NGOs – BFP has most recently engaged with Technoserve, SAFIRE, CESVI and LEAD Trust, and works closely with AGRITEX. Through the agreement, the company provides the support of an agronomist to the farmer group, while NGOs often support with inputs and access to finance for implements such as tractors etc. The company indicated a high unmet demand for fruit and vegetables. In an interview, BFP's Agronomy Executive gave the example that in 2016, BFP required 5000 tons of guava, but were only able to source 700 tons. He indicated that in the same year, demand for tomatoes was 30,000 tons, but only 4000 tons were supplied[337]. The company projects its annual demand to be 21,000 tons of tomato; 29,000 tons of citrus; 1,000 tons of mango; 2,000 tons of guava; and 2,000 of butternut. For guava, BFP is buying from the field through semi-contractual relationships, but is engaging with Technoserve on a demonstration plot for guava intercropping other crops. Due to the high predicted demand for fruit and vegetables, the company indicated their interest in an expansion of smallholder production under contract farming. The company also indicated that new and relevant innovations that could further increase demand for produce are drying of fruits and production of resins. BFP also stated that on irrigation schemes, crops such as butternut, tomatoes and guava could be grown almost everywhere, with the appropriate support. It does not see

[334] Value Chain Sub-assessment.
[335] Value Chain sub assessment section 3.2.
[336] Value Chain sub assessment, sections 3.1.5.; 3.2.5; 3.3.5; 3.4.5
[337] Feasibility Study, stakeholder consultation, May 2017.

geographical location as an obstacle: the company travels across the country to get products, or provides transport for the products to be transported.

The Maramani community in Beitbridge (AER V), plot holders on the Shashe irrigation scheme, have introduced citrus under contract farming arrangements. This came about through the Nottingham Estate – a large-scale commercial citrus farm some 40km from Shashe – promoting a consultation among local plot holders in 2003[338]. Farmers showed interest in introducing a high-valuable marketable crop, with a preference for oranges, in view of capitalising on the long-term expertise of local farmers involved in citrus production in the area[339]. The community also expressed interest in wanting to have greater jurisdiction and ownership of the scheme, including the irrigation infrastructure[340]. Beitbridge Juicing, a juicing factory mainly producing orange concentrate in the district, was interested in starting a collaboration. Beitbridge Juicing and Schweppes, also located close by, represent a substantial potential market in reasonable proximity to the scheme and give local growers a competitive edge. In 2010, the Maramani Community asked Cesvi to support development of the irrigation scheme[341]. Working with the community, a new model was proposed, which promoted a paradigm shift to turn the community from traditional subsistence agriculture to a commercial enterprise by linking together: traditional knowledge of the area and its resources; local expertise from existing commercial ventures; market access through the local processing plant; commitment to the implementation of a long-term strategy by traditional and local leaderships; and donor funds through the technical support of a NGO[342]. Importantly, the model embraces a common vision defined by the community, in which rural perceptions of food security ("food crops") remain the principal objective[343], but with different perspectives also adopted considering new opportunities to change their short-term goals to a long-term commercial outlook[344]. For example, in addition to citrus (a high value crop with a lag time of at least 5 years), inter-cropping of cash crops between rows of citrus trees was introduced to enhance immediate returns of food and funds for development and maintenance, compared to the traditional citrus culture. Following the introduction of young orange trees, which take at least four to five years to reach maturity, intercropping between the trees became an established practice. Crops such as seed beans, squash, sweet potatoes, turnips, cabbage and maize were also cultivated, either on contract for cash or for basic food requirements. This way, immediate cash returns are made available by using land between trees, and signifies the community building adaptive management into a long-term planning perspective in terms of commerciability. Production was supported through a designated 'project manager' to oversee production operations, in this case an individual from CESVI[345]. Crucial to building trust with the Shashe community was the creation of a demonstration/trial plot, or 'mini-farm', which was started at the outset of the project and continues to be a useful adjunct to the development and introduction of farming and technical innovations, hands-on management, and identification of production and management problems[346]. Despite the community receiving knowledge of the advantage of cash crops, they were adamant that portions of plots should remain for food security crops[347]. Ensuring this was built into the model design was also crucial to building trust and community ownership.

Sesame – a climate-resilient crop that can be grown in dryland areas – presents a potentially huge opportunity for farmers to enter the formal export market. This is because demand for sesame is almost wholly export-driven, with demand from key buyers growing year on year[348]. It is also relatively easy to cultivate on drylands, requiring few inputs and relatively easy cultivation practices. Currently, sesame is grown in dry areas such as Muzarabani, Gokwe, Binga and Hwange and Chipinge districts, with approximately 10,000 smallholders in production. Farmers typically rely on seed from contractors and some from local seed recycled from their harvest. While farmers are producing sesame under monoculture, it can also be intercropped with maize or beans, to increase returns per ha. While the sesame value chain is underdeveloped, with only a few private companies trading, namely IETC (Export Trading Group), Sidella and Olam, there is significant deficiency in supply. To give an indication (exact numbers could not be ascertained in interviews with companies during Feasibility Stage), farmers' production is below 400 MT per year, yet IETC has indicated wanting to receive as much as 50,000 MT annually for export[349]. In 2015, Olam approached SNV requesting if their project

[338] CESVI. 2017. Country Case Study: Zimbabwe. CESVI.
[339] Ibid.
[340] Ibid.
[341] Ibid.
[342] Latham, C. J. K. et al. 2015. From Subsistence Agriculture to Commercial Enterprise: Community management of green technologies for resilient food production. Future of Food: Journal on Food, Agriculture and Society. 3(2), pp. 8-17.
[343] Ibid.
[344] CESVI. Tackling climate change – from big international treaties to small rural communities: the 'Shashe experiment'.
[345] Value Chain Sub-assessment.
[346] Latham, C. J. K. et al. 2015. From Subsistence Agriculture to Commercial Enterprise: Community management of green technologies for resilient food production. Future of Food: Journal on Food, Agriculture and Society. 3(2), pp. 8-17.
[347] CESVI. Tackling climate change – from big international treaties to small rural communities: the 'Shashe experiment'.
[348] Value Chain Sub-assessment.
[349] Value Chain Sub-assessment, stakeholder consultation, November 2016.

farmers could supply 10,000 MT. While this was not achievable, it indicates potential demand in the market. In an interview with Sidella, Sidella indicated Chiredzi, Binga, and Buhera are preferable areas of expansion, which are low rainfall areas. Stakeholders, mainly private companies and AGRITEX believe that the potential of sesame has not been fully exploited. In the example of Welt Hunger Hilfe interventions under ZRBF in Bubi, Umguza, Umzingwane and Nkayi, the IETC has supported farmers in terms of training and commitment to buy the crop. The farmers have bought own inputs and the WHH project has contribute with Farmer Field School trainings. With an initial expense of 250USD / ha, a farmer can expect to grow 1.5 T of sesame per ha, if the right practices are applied. The crop has been sold at between 55-70 c/kg in recent years. That means that a farmer with a 1ha plot and a 1.5 T harvest would be able to earn between 825 and 1050 USD, making a profit of about 575-800 USD after subtracting initial investments. Even if the harvest is not optimal at e.g. 1 T/ha, farmers would still be able to get a decent profit in comparison to other crops grown by small holders in Southern Zimbabwe. Most farmers opt for a 0,5ha investment in the first year, while learning how to grow the crop and are then able to expand in the following years. In terms of value addition to sesame, WHH informed that usually the company buying the sesame would provide smallholders with appropriate storage bags, limiting the need for value addition investments. Harvest is relatively easy with sesame and does not require additional equipment. Also, as a relatively new crop, there are no well-defined gender norms and practices for sesame. In FGDs, famers indicated that sesame is not yet defined as a men's or women's crop as is the case with other cash crops like cotton.[350] For those crops regarded as women's crops, women control their production and marketing. Therefore, the status of sesame offers some opportunity for women to "claim" the crop, supporting gender empowerment. Despite this possibility, there is a high risk that as sesame becomes commercialised, men will push women away from control of market proceeds. Despite this fear, FGDs with women viewed involvement of men in crops termed "women's crops" as important to increase household income[351]. Further FGDs revealed that if a crop is produced under contract farming, there is a higher chance of household transparency as the transactions are often publicised at meetings and within the local community[352]. Sesame production labour requirements were reported by contracting companies as much less than for cotton, which alleviates women's burden as they provide the bulk of household farm labour.

### *5.3.3 Innovation Platforms as a tool to facilitate market linkages for climate resilient production*

Several stakeholders and projects in Zimbabwe have emphasized the importance of building the capacity of both AGRITEX staff and smallholders to facilitate market linkages and engage with the market. Innovation Platforms are an example of how this can be done and successful examples can be found in Zimbabwe and elsewhere.

Examples in Zimbabwe include: Innovation Platforms on smallholders' integration into the goat value chain facilitated by ICRISAT in Insiza, Gwanda and Matobo; an Innovation Platform on uptake of high-nutrient beans among smallholders facilitated by CIAT and the Pan Africa Bean Research Alliance (PABRA) in Chimanimani; and an Innovation Platform on wheat improvement practices in Whedza carried out by the International Centre for Agricultural Research in Dry Areas (ICARDA). All efforts have been implemented in close collaboration with AGRITEX and DR&SS. Boxes 9 and 10, below, summarise two of these examples to show how Innovation Platforms have proved a successful way for stakeholders to establish a dialogue and collaborate around shared issues, analyse the gaps and challenges, and design mechanisms to solve challenges across the value chain, resulting in the integration of smallholders into the market.

Box 9: Case study: Innovation Platform for beans in Chimanimani

**An uphill process of introducing new bean varieties**

Common bean is considered a cheap and effective source of protein for smallholder farmers. In 2010, the Crop Breeding Institute of DR&SS introduced the micro-nutrient rich, high yielding bean variety NUA45 in Chimanimani in Manicaland, an area with good bean production conditions but also a high degree of malnutrition. The NUA45 bean variety can produce up to 2.9 t/hectare, in comparison to the average productivity of 0.4 t/ha of inferior varieties that were more commonly produced in Manicaland.

However, DR&SS soon realized that adoption of the new, improved variety would not come automatically. The new bean variety had been used in food and nutrition support programmes and farmers associated the bean with food for disadvantaged communities. Also, the common

350 Value Chain Sub-assessment, stakeholder consultation, November 2016.
351 Ibid.
352 Ibid.

bean market and consuming public were sceptical about the new bean variety because of its physical appearance. Consequently, the adoption of the variety was minimal on farmers' fields and it was not popular on local markets, despite its rich nutrient base.

Through a variety of field demonstrations, participatory variety selection exercises with communities and Farmer Field Schools, it was hoped that widescale adoption would follow. However, adoption was limited mostly among farmers who had participated in demonstrations and their immediate community. DR&SS discovered that one of the main reasons that farmers did not take up NUA45 bean production was that value chain key actors had opposing interests and did not work together. Agro-dealers were sceptical to store and sell the NUA45 variety, and big buyers as well as local household consumers continued to demand light-skinned, less nutritious varieties such as Gloria and Sweet Violet. This presented a great challenge to the farmers who had taken up the production of the NUA45 bean and found it difficult to sell - and to DR&SS, which struggled to find a way to save both the adoption of the variety and the production of the crop from a total collapse.

In 2015, DR&SS and partners initiated an Innovation Platform under the CIAT-PABRA bean production support initiative[353] with the aim to improve food and nutrition security in the Chimanimani area. The Innovation Platform created a forum for interaction among a group of relevant stakeholders around the adoption of the new bean variety. In this case, the innovation process was connected to two Farmer Field Schools with practical demonstration and innovation areas at Nyanyadzi and Gudyanga Irrigation Schemes in Chimanimani district.

The Innovation Platform for Technology Adoption in Chimanimani involved the following aspects:

- **Baseline survey** to understand the bean sector in the province and the district
- The **selection of key actors** to participate in the platform. In doing so, emphasis was on the involvement of all critical stakeholders along the value chain as well as gender equal participation.
- Establishment of **governance and management frameworks** with gender equal participation.
- A series of **stakeholder problem analysis and innovation workshops** were carried out. This collective analysis of challenges and solutions ended up in stakeholders formulating a strategy for developing the value chain and allocating roles for implementation.
- The Innovation Platform drew from experiences in **testing solutions together with smallholders in the field**. Farmer Field Schools were used as a platform for learning and engagement of smallholders.
- Finally, the Innovation Platform functioned as **a space to develop and maintain strategic linkages across the value chain**. Linkages between farming communities and inputs suppliers, between farmers and service providers, between farmers and financial institutions as well as between farmers and potential markets were created and made strong to ensure that the full value chain functioned.

Key achievements in farmers welfare through innovation platforms include:

- **Increased knowledge of bean production and best management practices among smallholders.**
- **Increased adoption of the bean variety:** Adoption of the improved variety increased among the participating farmers by 79%.
- **Improved yields:** The capacity building efforts also led to an increase in yields from an average of 0.9t/ha to a new average of 1.8t/ha[354].
- **Impact on income levels:** As part of the FFS's participating farmers produced a total of 10,800kg, a jump from 5,400kg produced from the same area in 2014. Due

[353] This initiative is under the funding of the Swiss Agency for Development and Cooperation (SDC) and is being implemented by the International Centre for Tropical Agriculture (CIAT) and the Pan Africa Bean Research Alliance (PABRA). These are the key partners working with the Department of Research & Specialist Services (DR&SS).

[354] Although there was a general shift in yield levels due to other factors, the percent change attributable to the Innovation Platform for Technology Adoption (IPTA) approach was 80% according to DR&SS based on observations of average yields across the district and among non-participating farmers and participating farmers.

to innovation platform efforts of linking farmers to markets there was an average increase in price from around US$1.00/kg to US$1.40/kg – a percentage increase of 40%. As a result of both improved yields and prices, the returns per farmer participant rose to US$252 from an average baseline value of US$90.00.

DR&SS concludes the achievements were largely attributed to the collective identification of issues affecting the value chain, collective development of possible solutions, stakeholder commitment and buy-in. The clearly demonstrated positive change in yield levels, income and farmer welfare also guarantees increased adoption of the demonstrated practices and varieties by communities.

*Source:* Freeman G. et al. (unpublished) Innovation Platform Approach, a Life Changing Strategy for Technology Adoption in Chimanimani District, Zimbabwe. ICRISAT.

Box 10: Case study: Smallholders integration into the goat value chain

ICRISAT's Innovation Platforms in Gwanda, Insiza and Matobo worked with a variety of stakeholders, including smallholders, traders, rural development agencies and AGRITEX Extension Officers, to develop the livestock value chain. The groups collectively identified challenges in the value chain as well as solutions. The platform in Gwanda decided to tackle its problems with livestock marketing. Farmers were often selling goats to middlemen at the farm, and since there was little completion among buyers, prices were often low. The Innovation Platform came up with the solution to organize monthly auctions for goats. Over time, the auctions grew in importance as a marketing channel among farmers, who could fetch better prices at auctions in comparison to farm gate sales. Farmers now plan ahead and sell their livestock at auctions, where they can expect a certain price. The expectation of an improved profit has also impacted in that farmers invest in their animals and this has also improved the adoption rate of a range of livestock management technologies, e.g. feedlots to see their animals through drought.

*Source:* ICRISAT. 2013. Seven lessons learned to catalyse African innovation through engagement platforms. CGIAR.

### *5.3.4 Training and capacity building in 'farming as a business'*

Directly related to farmers' ability to capitalise on market demand is their ability to treat 'farming as a business'. Training in 'business enterprise skills', or market analysis, is a strong component of USAID, Scaling Up Adaptation, SHEP and FAO interventions. In USAID's ZIM-AIED project, successful approaches have included skills in enterprise budgeting, contract management, credit control, record-keeping and basic principles of marketing. The Scaling Up Adaptation project has successfully worked with farmers in a participatory way to jointly analyse value chains and market requirements in terms of quantity and quality, as well as has facilitated links with markets. This has contributed to that farmers have increased incomes significantly, for instance in the honey value chain. The SHEP programme that AGRITEX is currently implementing with JICA focuses on promoting farmer as a business by taking farmers to meet business actors directly to get a better sense of the functioning of the value chain, the market demands and requirements and a direct link to relevant market actors. Farmers have increased their incomes as a result and the working relationship between extension agents, private sector and farmers has improved. Such examples point to the importance of a participatory and hands on approach to capacity building of farmers in farming as a business.

In the evaluation of the FAO's Market and Agri-Services Linkages Component of the Smallholder Irrigation Support Project, discussions with farmers at all schemes visited indicated that farmers recognise the need to link production to market demand and secure markets prior to production. However, evidence suggests that in each season, farmers continued to produce crops they had been accustomed to producing and target markets they were used to, instead of identifying the markets with most opportunity to guide production. Market assessments were also not conducted prior to production. The evaluation noted that at all schemes farmers wanted more training on marketing, and that the early impacts of market training provided by the intervention indicated positive steps to changing the behaviour of farmers to improve their income security over the long-term.

The FAO experience suggests that it is particularly pertinent to provide training on how to read and interpret markets and, significantly, how to turn market opportunities into action to increase smallholders' profitability. Particularly, the FAO experience highlights that training must also engage agribusinesses and distributors in certain aspects, such as their capacity to contribute to providing training and inputs in the quality of crops they would like to purchase.

A fundamentally important aspect in any market training and value chain development activities is a focus on incorporating women farmers and making sure that training addresses the needs, interests and opportunities and constraints relevant to both genders.

### *5.3.5 Addressing gender dimensions in agricultural value chain development*

In Zimbabwe, women's crucial contribution in agricultural production is often invisible in many agricultural economic assessments and service provision, and gender analyses are only recently informing market and value chain analyses and training interventions. Examples of successful strategies to promote gender equal participation and benefit from agricultural production often work in a two-pronged approach by employing both a gender equality and women's empowerment approach[355]. On the one hand, **a gender equality approach works towards ensuring that both males and females have equal opportunities**, e.g. through extension services to both genders, gender parity in access to land and equal participation in decision making. On the other hand, **a women's empowerment approach explicitly targets female farmers with support on identified agricultural activities**, for instance, extension services targeted to women's routines and needs, particular support to value chains that are traditionally the domain of women, such as the small livestock value chain.

The Agro Initiative Zimbabwe intervention carried out by Technoserve applied a gender sensitive market analysis to inform training needs and interventions for supporting gender equal participation and empowerment of female farmers. Technoserve provided tailored technical assistance to companies to integrate smallholders into contract farming arrangements and had a strong focus in terms of economic opportunities for women. It advocated for women's equal participation in agricultural activities – such as extension services to both husband and wife, gender parity in access to land, equal participation in decision-making and equal enjoyment of proceeds from agriculture. As a result, the project successfully exceeded the target to work with 40% women-led businesses and women smallholder farmers.

In a similar way, the Scaling Up Adaptation project analysed value chains with a focus on gender and achieved significant women empowerment results by focusing both on gender equal participation in value chain development, as well as targeting value chains which have traditionally been women related, such as the goat or small livestock value chain. The project complimented this by supportingd women's financial capacities through village savings and loan groups, an approach that has seen women groups gather substantial amounts and invest them into own small scale agricultural production[356].

The value chain sub assessment refers to a gender study by the ENSURE project[357], which found that women's daily calendars were oversubscribed, while those of men had a lot of free time. The study also found that there were high incidences of backlash from men when women generated money. To address these counterproductive gender issues, ENSURE engaged (as opposed to confronting) men. Male gender champions were appointed and utilised men's fora to address gender issues identified by the community during a process of social analysis. Behaviour started to change progressively, giving positive results. For instance, in village savings and loan groups, 95% of members were female at the start. However, through this approach the ratio changed to 50%:50%, creating a forum for influencing both men and women on gender issues to improve the efficiency and fairness of working practices

The value chain sub assessment also identified that while women mostly make use of informal marketing channels and spaces, contract or collective marketing can increase women's participation in formal markets as they do not need to travel far from the farm. Further, market linkage models that promote central and specialised management of production can benefit women who are often excluded from training and information services.

Further it was discussed in the value chain sub assessment, that while new climate smart crops may hold potential for women there is also a risk that as new crops, such as sesame, become commercialised, men will push women away from control of market proceeds. Despite this concern focal group discussions with women revealed that if a crop is produced under contract farming, there is a higher chance of household transparency as the transactions are often publicised at meetings and within the local community[358].

## 5.4 Access to and use of climate information

To build climate risk management into farming livelihoods (across rain-fed crop and livestock and irrigated production systems), farmers require access to accurate and timely climate information in a form they can readily

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356 UNDP/GEF Scaling Up Adaptation with a focus on rural livelihoods, terminal evaluation, 2019
357 Value Chain sub assessment, p. 34
358 Value Chain sub assessment, sections 3.1.3; 3.2.3; 3.3.3; 3.4.3

use. The relevant institutions therefore need to be able to provide it in a coordinated fashion. This section summarises best practices and lessons learned from previous and existing interventions to achieve this.

There are three different areas of focus in making localized, accurate and timely climate and hydrological information available for rural smallholders. These are: a) building infrastructure to increase coverage by weather/climate and hydrological gauging stations, b) building MSD and ZINWA staff and AGRITEX extension officers' capacity to understand climate information to support dryland and irrigation farmer's application, and c) packaging climate information so that it is easily understandable and applicable by farmers and Irrigation Management Committees.

### *5.4.1 Improving weather station coverage: use of low-cost weather stations*

As highlighted in Chapter 4, there are significant gaps and barriers to the country's ability to capture weather/climate information. While upgrading existing weather gauging stations is an ideal option to capitalise on previous investments, this can be more expensive than setting up new stations, depending on sensor requirements (manufacturer, technical specifications etc.) and whether there is a need to be able to send real-time data for early warning purposes. It is therefore important that investment in new weather and hydrological stations balances the need for precision meteorological measurements with the need for timely and widespread monitoring for early warning purposes, and the financial and institutional capability to operate and maintain the equipment in each case.

*Manual stations*

Low cost manual measurements (utilising cheap, plastic rainfall gauges and thermometers) are often used to help farmers understand climate variability on their own farm and be able to compare their own local measurements with those measured at the nearest weather station operated by MSD. This allows farmers to understand variability in rainfall within their own local environment and the degree to which other (official) measurements are representative of their experience. In turn, this helps interpret information they receive regarding CRA practices (which may be based on other data and hence require adapting), as well as building trust in other products, for example weather index insurance, which may be based on other satellite-based data sources. If manual stations are to be distributed to farmers, it is important that farmers receive training so that they can correctly read measurements, understand why differences between measurements may exist, as well as being able to decide when differences are significant for a particular application.

*Automatic stations*

Low-cost AWS are a useful supplement to existing manual and other AWS operated by MSD. Whilst synoptic class stations are needed under WMO regulations for precise and regular measurements (e.g. wind speed and direction @ 10m) at key locations (e.g. airfields), it is often sufficient and more appropriate given the context to be flexible regarding measurements for other purposes e.g. early warning of extreme and reduced rainfall, measuring agrometeorological conditions etc. This often leads to lower cost AWS being used for agricultural meteorological applications e.g. at an agricultural research station, or for measuring rainfall which may cause flooding e.g. as part of a hydrological gauging station.

In the past few years, the technology that has become available, especially with respect to precision parts and meteorological sensors, as well as their cost, has enabled the development of a range of AWS at a fraction of the cost (of the order of one tenth) of a synoptic station (approximately USD 25,000+). These stations, costing in the region of USD 2,500, are equipped with sensors which adhere to WMO standards (i.e. they are as accurate), and cost significantly less to install, operate and maintain. Some of these stations are 'all in one', where the range of sensors are integrated into a single body or structure. Their low cost and structure makes it cost effective to replace the whole unit if one part fails, reducing the time needing to be spent in the field (see Annex 19).

For all weather stations either upgraded or newly installed, capacity building of MSD staff and AGRITEX Extension Officers is essential, as undertaken and shown by the Strengthening Weather and Climate Change Information Dissemination Systems and Coping with Drought projects (see Chapter 3). Where possible, cloud storage should be utilised for both archiving/backing up the weather and hydrological station data in order to minimise the risk of hardware failures and losing data. Additional considerations need to take account of the ability to send and collect data in real time so that the data can be used for early warning. In this regard, the use of email (for manual stations), GPRS/GSM and Frontline SMS (for automatic stations) should be encouraged.

### *5.4.2 Enabling decentralised (district and ward level) interactions between MSD, ZINWA and AGRITEX*

During a drought, national level meetings are held, where stakeholders such as ZinWA, MSD and AGRITEX, come together to discuss the evolving situation and any climate/hydrological forecasts that are available. These meetings used to take place under the NEWU, often coordinated by FAO. Interactions at the national level occur reasonably frequently through the Department of Civil Protection's bi-monthly meetings, the Zimbabwe Vulnerability Assessment Committee (ZimVAC) activities, and MLAWCCRs Crop and Livestock Assessments. Whereas at the provincial and district levels, there are platforms which require the Provincial MSD Chiefs or the Department of Civil Protection to provide information, particularly to Drought Relief Committees and Food and Nutrition Security Committees.

Additionally, MSD has provincial meetings where provincial officers represent MSD and, in most cases, MSD presents the seasonal forecasts, as well as current weather. There is little information which can be used to link water catchment areas and expected rains within those areas to hydrological/water resource forecasts and this is a key gap in providing information on drought and the availability of water e.g. for irrigation management. This collaboration is hampered because each institution works with different committees and councils:

a. AGRITEX meetings include the Extension Officers of the particular area or district as well as farmers.
b. ZINWA meetings are with Catchment Councils.

In the past, preseason meetings at the district level have tended to focus mostly on dryland farming (working with dryland farmers to understand the seasonal forecast and translate it into useful information: when to plant, which varietals to plant, whether to apply fertiliser e.g. through the PICSA approach, see Chapter 3). There is clearly a need to also include IMCs and ZinWA, as they also need to plan efficient water allocations and use, either as part of these meetings, or as separate meetings focussed on irrigation requirements and related information e.g. using weather forecasts for irrigation scheduling. Planning these meetings needs to also account for past experiences and best practices e.g. the fuel allocation for the ward-based officers should be in the form of cash, as coupons were found not to be appropriate/useable in some areas in previous projects. These seasonal forecast dissemination meetings also should be carried out in conjunction with the volunteer station maintenance visits. This was tried under the AFSMS, which also had a component on rainfall measurement and recording under the refresher trainings as well as station visits. These refresher trainings and including the farmers by collecting rainfall measurements are all key requirements to enabling them to better understand the forecasts and use them to make risk informed decisions.

### *5.4.3 Communication strategies and media for climate information to reach farmers*

One of the key successes of the Oxfam UNDP/GEF project in partnership with AGRITEX and MSD and young researchers, was to identify innovative ways of communicating weather/climate information to farmers. This includes understanding how farmers value and receive the information as well as efforts to integrate with existing indigenous knowledge. Innovators also spent time at MSD creating agricultural advisories and tailoring the weather/climate data based on the feedback obtained from farmers. In implementing such a focus, UNDP/GEF project highlights the following lessons learned:

- By distributing low cost rainfall and temperature sensors, farmers can collect data on their own farm/land, which helps visualise and understand weather information and forecasts;
- Development and testing of local seasonal rainfall forecasting is required and this should be complemented by tailor-made climate services, involving the active participation of farmers, MSD and AGRITEX;
- Dissemination of climate information should be through different dissemination strategies and mechanisms for different users operating in different circumstances, and this should include the use of existing extension channels, electronic user interface platforms, such as use of mobile phones and radio, and interactive digital platforms (see Annex 20-21);
- Capacity building is needed for farmers to understand climate information and how they can use it in practice as well as designers to appropriately package climate information in formats that are useful for extension workers and farmers; and
- All local weather stations should be integrated into the national meteorological information system and this should be informed by climate research, modelling and prediction.

Discussions with the team indicated that it is often difficult working with different telecoms companies who, in general, would like to own any services that are provided. This has implications for the use of Unstructured Supplementary Service Data (USSD) technology, which would be harder to control, and would rely on Econet, as they are currently the sole provider of this technology. Whilst farmers surveyed indicated that they can use USSD technology, they expressed a preference for SMS technology for a number of reasons:

- SMS does not always require the ability to navigate menus and interact with technology online;
- SMS allows for the user not being online when needing the information (SMS will be received when network coverage is restored;
- SMS allows storage of the information for later – encouraging sharing with friends and other farmers.

It is therefore expected that the **adoption of SMS would be more widespread and quicker**, allowing more flexibility with service providers. It is however dependent on cost and sustainability. Importantly discussions with the team indicated that sustainability needs to be built into the project design from the beginning. In this regard, it was **suggested that farmers should pay a nominal fee for any services that are provided from the start of the project**. This ensures that services are not expected to be provided for free in the future, avoiding a shock and discussions when fees are charged later.

An evaluation of the SMS-based platform utilised as part of the SWCCIDS project showed that the monthly subscription costs, using the ESOKO[359] platform, are the largest cost along with individual SMS costs[360]. Thus, the overall costs per farmer reduce as the scale of the system (number of farmers) increases. **Farmers were shown to be able to handle up to USD 0.5 per month subscription costs, with the costs during the project being USD 0.41**. Whilst some farmers may not be able to afford this, 'opinion leaders' will be able to and they can share information with other farmers. It was also recommended **to distribute information to both extension workers and lead farmers** as extension workers are sometimes a barrier to the flow of information - they need to travel and can't get everywhere all the time. It is then envisaged that if farmers need further information for decision making they can arrange to meet extension workers. See Annex 20 for a description of the SMS technologies currently being used.

### *5.4.4 Utilising local Universities and skills to provide technical support*

Both the University of Zimbabwe (UoZ) and Harare Institute of Technology (HIT) have provided support to ongoing projects, such as the UNDP/GEF project: Scaling up Climate Adaptation Solutions (see Chapter 3). Working together, these interactions have proved beneficial to the project in several areas, largely because the Universities have a large pool of technical expertise and students who are keen to gain experience and undertake work as part of their academic development. This is an advantage when implementing technical solutions for which there are few qualified technicians in government, as well as providing an opportunity for government departments to see the advantages of employing students after they finish their studies.

In the Oxfam UNDP/GEF project, UoZ and HIT have undertaken surveys regarding how forecasts affect behaviour; UoZ[361] successfully mobilised farmers working with AGRITEX extension officers to collect data focused on agriculture. Complementing this work a private company (Digital Velocity) focused on the ICT aspects of the survey and recommendations for future development work.

Climate information courses and related initiatives, which are provided by Universities are key resources to enable recommended approaches. A detailed description is presented in annex 22.

*Water resource modelling*

UoZ Department of Civil Engineering undertakes a masters course in Water Resource Modelling with elements on how to use models to predict systems performance under future scenarios, focussing on managing uncertainty of water in situations where there is insufficient information and the need to predict and decide on management approaches to be taken for future events.

*Flood risk assessment*

UoZ (Department of Geography) has undertaken a flood risk mapping of Zimbabwe which is being promoted for local level planning through ZRBF. This risk mapping provides a useful resource against which the siting of new irrigation schemes and risks can be gauged, assessing the likely return period of floods.

[359] Esoko. 2017. Esoko. Available on: https://esoko.com/ (Accessed 19 May 2017)
[360] Digital Velocity. 2016. Evaluating the use of ICT in climate change adaptation programming in Zimbabwe. Case study on strengthening weather and climate change information dissemination systems for smallholder farmers in Gutu, Chirumhanzu and Zvishavane districts. Oxfam.
[361] UZ,Geography department – Chris Chaguma

*Agrometeorology*

UoZ (Department of Physics) has been working with farmers to support their use of seasonal forecasts and knowledge of climate variability and change.

## 5.5 Institutional coordination and capacity building

***National level capacity building:*** Lessons learned from climate resilience building projects, including UNDP/GEF's Coping with Drought project, Scaling Up Adaptation and the work of ZRBF indicates the importance of effective national government leadership and institutional and legal frameworks to coordinate and guide climate change adaptation across levels. UNDP's efforts in support of MLAWCCR capacity building have demonstrated the value of long-term, embedded support and resources within a Ministry to push through change, as highlighted by the success of the Climate Change Management Department in leading adaptation planning at national level.

***Sub-national level capacity building:*** Under the Coping with Drought project, observations from Chiredzi district showed a lack of capacity and leadership in local government around climate change adaptation. The Scaling Up Adaptation project integrated this learning in its design and UNDP is supporting local level adaptation planning through ZRBF interventions and other projects. Strong local institutions, such as Irrigation Management Committees and farmer associations, are a critical success factor for adaptation, particularly given that climate change is dynamic, so new challenges will always be emerging. These challenges require well-resourced local administrative and technical institutions that are able to continuously collect evidence and lead evidence based planning to provide solutions that are suited for the local context. For example, the project sited the presence of Chiredzi Research Station as strategic in the development of new technologies relevant to the biophysical conditions of the district. The institution needs resources and human capacity to further carry out this role.

# 6 Findings and recommendations

This chapter presents key findings on the climate vulnerabilities of agricultural livelihoods in Zimbabwe and the recommendations towards strengthening the resilience of vulnerable agricultural livelihoods.

The chapter first outlines overall findings, summarising the identified climate vulnerabilities, selection of target area and population, selection of outputs and the baseline in terms of existing policy and institutional framework, ongoing and past interventions and lessons learnt. This is followed by findings and recommendations for transformational approaches to building smallholders' adaptive capacity to climate change in southern Zimbabwe. This section firstly outlines overall implementation principles to achieve paradigm-shifting, transformational change, and then provides detailed intervention and costing recommendations. Finally, the chapter outlines innovation, cost effectiveness and sustainability considerations.

## 6.1 Overall findings

As described in the analysis in sections 1.2-1.3., the Southern regions of Zimbabwe, in AERs IV and V, are currently and have historically been prone to severe climate risks, most prominently droughts and mid-season dry spells, which contribute significantly to the vulnerability of smallholders' food and income security and livelihoods. The rural populations in southern Zimbabwe are among the most vulnerable to and suffer the highest risks (severity of hazards) due to historic climate, its past trends over the last 40-50 years, and projected climate change. Acute levels of poverty and hazards such as HIV/AIDS rates, crop pests and livestock diseases further accentuate vulnerability to climate-related hazards increase these already high and increasing risks. Also, due to unsustainable farming and land management practices, the southern Zimbabwean catchment areas experience increased degradation of land, forest and water resources, which in turn negatively impacts on irrigation infrastructure, due to siltation and reducing water availability as a result of reduced soil moisture holding capacity. This reduces the ability of communities to adequately deal with climate risks.

The observed and future climate change projections for Zimbabwe indicate an increase in annual mean temperatures, ranging from 0.5 - 2.0°C by 2030; 1.0 - 3.5°C by 2070 and 3.0 - 4.0°C by 2100. Further, changes in precipitation and water availability are expected. A decrease in rainfall is expected to occur in all seasons; by the 2080's average annual rainfall is predicted to be 5% - 18% below the 1961-1990 average. Rainfall and runoff is expected to decrease by 15% and by 20% respectively. At the same time, Zimbabwe can expect a changing seasonality with a shorter and more intense, core rainy season occurring later in the year. While the Southern region of Zimbabwe is already prone to extreme events such as droughts, mid-season dry spells, floods and tropical storms, increased in frequency and intensity of extreme events is predicted. Namely, predictions point towards longer mid-season dry spells, increase of 10% in the longest dry spell and increases in aridity.

Considering Zimbabwe's significant levels of vulnerabilities in the agricultural sector and low level of preparedness for the observed and projected climatic changes, the feasibility study focused on exploring the following solutions.

- Climate resilient water infrastructure and efficient water use for agriculture
- Climate resilient agriculture practices and value chain development
- Climate information services for informed agricultural decision making

These needs are clearly aligned with national policies, strategies and economic blueprints. The country's economic blueprints ZimAsset (2013-2018) and the Transitional Stabilisation Programme (2018-2021) identifies the agricultural sector as a key economic sector, while also recognizing the negative impact of climatic changes on the country's agro-based economy. The climate change policy, the climate change response strategy and the nationally determined contributions prioritises resilience building for vulnerable agricultural livelihoods and irrigation and water use efficiency in agriculture, climate smart agricultural practices and climate information systems are promoted.

Based on extensive consultations with MLAWCCR and other key stakeholders , literature analysis, sub assessments, and the targeting exercise as documented in section 1.7, it is recommended that the proposed project should target the three southern provinces, Matabeleland South, Masvingo and Manicaland, and in particular focus on districts based in the Save, Runde and Mzingwane river basins given the high vulnerability to climate change. It is recommended to target districts and wards prioritised based on the historic and projected climate risks and vulnerability levels. The targeting exercise identified 15 priority districts, with a total of 386 wards, and 137 priority wards in the southern provinces.

Although Goz investments and donor assisted programs have focused on enhancing agricultural livelihoods through a range of interventions, there are significant gaps when it comes to adapting the sector to climatic changes. The changes in climate significantly impact rainfed smallholder farmers, especially women, threatening food and income security owing to climate induced water scarcity and declining agricultural production.

This feasibility study finds that potential benefits from years of investment in smallholder rural irrigation development intended to boost food production have been or could be lost due to climate induced dry spells, high temperatures, as well as flooding and torrential rains. In particular, there has been a lack of a climate resilient approach to irrigation development in terms of design and selection of water use efficient irrigation technologies - and climate risk management has not been embedded sufficiently into the O&M of irrigation schemes. Despite significant irrigation investments from both Government of Zimbabwe and development partners, there also remains a gap in coverage, at scale, particularly in rural, communal areas in the southern provinces where the vast majority of smallholders reside.

Although there is growing awareness of the need for smallholders to take up climate resilient agriculture (CRA) practices to adapt to climate risks and increase production, Zimbabwe does not yet have a concrete action plan for promoting CRA among smallholders on a national scale. Elements of CRA are promoted in many projects, and while this does contribute to reducing climate vulnerabilities, there are challenges in ensuring systematic data gathering and evidence based implementation of CRA practices effectively at scale. While the agricultural extension system in Zimbabwe is well structured and competently staffed from national to ward level, agricultural extension staff expressed a need for improving the knowledge on how to integrate climate risks into agricultural planning and implementation as well as improving agronomic knowledge on proposed climate smart crops and livestock breeds.

Equally important, based on experiences from previous initiatives, interventions to enhance smallholder farmers livelihoods should take a market approach to ensure results and sustainability. When smallholder farmers take up new CRA practices and products, it is important to ensure development of climate resilient value chains, ready markets for the new products and access to financial and insurance services. However, capacity gaps exists for both smallholder farmers and the agricultural extension system, both in terms of 'farming as a business', market analysis for climate resilient crops and livestock, climate risk assessments for production as well as knowledge and networks to improve market links. Similarly, there has been limited attention to gendered climate risks in value chain development.

The feasibility study has identified a significant gap in the country's ability to collect weather/climate information as well as significant gaps in the development and dissemination of climate-related information for agricultural decision making. Namely, the study identifies gaps in the weather station network, technical capacity challenges in analysis and communication of the seasonal weather forecasting and monitoring as well as gaps in hydrological monitoring and water resource management.

A significant barrier to climate resilience for agricultural livelihoods is the lack of a coordinated response to climate change, especially in the management of multiple stakeholders across the water and agricultural sectors, whose collective activities are important for resilience building. Limited coordination by government service providers contributes to inadequate service provision to smallholders as well as national adaptation planning efforts.

Although the GoZ identifies climate change as one of the major threats to the country's development, its efforts are constrained, most significantly, by limited fiscal capacity. This has resulted in inadequate investment in designing climate risk management strategies, constrained service delivery to support adaptation and mitigation activities and limited implementation of adaptation interventions. The potential support from GCF is seen as a window of opportunity to build technical capacity of key stakeholders in adaptation, enhance systematic and coordinated adaptive management and implement effective climate adaptation solutions at scale.

Support to building climate resilient agricultural livelihoods in Southern Zimbabwe will directly contribute to achievement of national adaptation goals and Government of Zimbabwe's aim to ensure food security. Effective adaptation of agricultural livelihoods of smallholder farmers will directly support income security and protect the livelihoods of the rural poor as well as strengthen the country's capacity to adapt to climate change, improved risk management and preparedness for climate change impacts. In addition, it will address some of the country's most pressing issues such as high rural poverty levels and rural to urban migration. Transformational approaches to building climate resilient agricultural livelihoods in southern Zimbabwe

This feasibility study concludes that smallholder adaptation to climate change is achieved through the adaptive management of agro-ecosystems and landscapes to sustain and increase yields in the face of increasing climate risks. Smallholders must possess the capacities, motivation and resources to adopt climate resilient production practices and continuously adapt them to an evolving climate. In southern Zimbabwe, these resources must include, as a priority, **sustainable, efficient water supply** and a **diversity of climate-adapted, high-value crop varieties**. Smallholders have traditionally managed risk by diversifying production and income. Alternative, climate resilient crops provide food and income security opportunities to communities in the southern provinces, where maize production is under pressure from increasing climate change. The adoption of CRA practices and technologies *at scale* is significantly enhanced if farmers are motivated by and assured of ready markets for their crops. Market linkages and training in farming as a business for farmers and the AGRITEX extension service supports farmers to address climate risks in agricultural production and, overtime, establish micro-small enterprises. The establishment of **multi-stakeholder Innovation Platforms** provide a platform for stakeholders to work collaboratively to overcome production and marketing challenges and leverage further private sector investment in smallholder climate resilient agricultural production. Farmers will also benefit from more accurate and dependable **climate information,** to allow them to plan agricultural tasks in the face of climatic changes. Enabling support through coordination, knowledge management and training from government and non-government entities, including private sector partners, will allow smallholders' to acquire and sustain the capacities and resources needed for adaptive agroecosystem management.

To implement such an intervention, a **holistic** approach, **framed by climate risk analysis**, is recommended to be the key implementation principle. This encourages institutional collaboration and multi-stakeholder consultation, as it is based on the understanding that building climate resilience requires a variety of different components and multiple stakeholders to work together. Further, an '**end user-centric**' approach should be employed, to place community participation and ownership at the centre of interventions. Service delivery needs to be tailored to the specific climate vulnerabilities smallholders' face, if climate risks are to be mitigated. This is important from a conceptual viewpoint (as farmers constitute a key actor in any policy and service delivery decision-making), as well as from a design and implementation principle in its own right. Valuable indigenous knowledge is a key information source that should be used to inform investments. Finally, a '**market-development'** approach should act as the driver of an 'exit strategy' for the project. The private sector is considered integral to supporting smallholder integration into value chains and adding investment into improving climate resilience of value chains. Opportunities provided by private sector engagement has the potential to lift smallholders out of poverty and promote micro-small enterprises and a vibrant rural economy. As climate change risks and impacts are gendered, the project also needs to analyse how interventions can contribute to gender equal opportunities for food security and income generation for smallholder farmers. How to improve the role of women as business entrepreneurs should be a central area of focus in this approach.

## 6.2 Climate resilient water availability and storage and its efficient management

This feasibility study recommends a focus on increasing water availability and water storage capacity, reducing water loss and enhancing water use efficiency through installation and operation of appropriate, **climate resilient irrigation infrastructure and technologies.** It is recommended that sustained access to water for smallholders is provided through a climate resilient design approach on 21 **irrigation schemes** across 15 priority districts (see Section 1.9). As noted in the section on targeting in chapter 1, the irrigation schemes were primarily selected based on climate and vulnerability analysis (based on ZRBF's climate hazard mapping) and validated by a series of consultations with government officials, donors, provincial engineers and smallholders. Consultations with other donors, particularly IFAD and FAO, were conducted to facilitate synergies and avoid overlaps. This coordination and collaboration should be maintained throughout project implementation. Support to Irrigation Management Committees to increase farmers' capacity in climate risk management, should be provided to the 21 irrigation schemes, and capacity building of DoI, in the design of climate resilient irrigation infrastructure and maintenance, and AGRITEX, in support and management of climate resilient agriculture production on schemes. Based on the Climate Resilient Irrigation and Solar PV sub-assessment analysis, solar power is recommended to be introduced on schemes with a maximum of 30ha, as a viable and reliable source of power for small-scale rural irrigation schemes, as well as providing mitigation co-benefits.

### *6.2.1 Design of site-specific, climate-proofed irrigation schemes*

Based on analysis of best practice and lessons learned from existing efforts and barriers identified, key recommendations to **implementing climate-proofed irrigation** schemes are provided below[362]. The reasoning for the selection and design of site-specific, climate-proofed irrigation schemes, is documented in section 5.1 of this feasibility study and detailed in the Climate Resilient Irrigation Sub-assessment[363], the important elements of which are summarised in the following sections.

1. *Employ a climate resilient design approach to implement 21 climate-proofed irrigation schemes across the southern provinces*

[362] See Climate Resilient Irrigation Sub-assessment for full details
[363] Cf. Climate resilient irrigation Sub-assessment, section 3.5

It is recommended at the outset of the project that baseline data is collected for the irrigation schemes to allow the project to measure progress over its duration. Technical engineering designs per scheme, pertaining to procurement and contracting modalities, will need to be produced. From best practice and lessons learned, and primarily drawing on practical experience from CRIDF's pilot projects, this should be based on the following per scheme:

a) **Hydrological modelling** (now and considering climate change trends) and **flood forecasting** should be factored into design, to determine the methods of climate proofing irrigation infrastructure, such as **above flood level location** and **structure anchoring,** and selection of appropriate **water use efficient** irrigation technologies (see Chapter 5 for best practices).

b) A local level **Climate Change Risk Assessment** per irrigation scheme should be conducted to ensure community needs and the specific climate risk profile communities face are addressed in climate-proofed design. **Gender, Equality and Social Inclusion** and **political economy analysis** should also be applied to ensure equitable benefits are realised in the community.

c) **Financial and economic assessments** (a Cost Benefit Analysis, or similar) should be conducted to determine the viability of irrigation schemes to be maintained by the community. This also determines the appropriate operation and maintenance arrangements needed in the face of increasing climate change impacts, to ensure communities are able to sustain schemes beyond project support. Specific recommendation for O&M support are as follows:
    a. Budgets should consist of capex grant financing, both upfront for design and installation of irrigation infrastructure, and for one year after installation in O&M, to support the initial start-up training and savings of revenue-funded O&M by the community.
    b. O&M costs should be covered in the first year by the project budget to allow Irrigation Management Committees (IMCs) time to build climate risk management planning and O&M into their day-to-day operations and to build resources for O&M.
    c. Following this time period, O&M costs should be covered by funds collected in a 'Maintenance Fund', which all members of the community who benefit from the scheme contribute to on a monthly basis from the start of the project, and/or is deducted from revenues (as stated in the scheme Constitution) (see below).
    d. Over time, this should provide enough funds to pay for equipment repairs and technicians. Profits generated from surplus production from the first year (two double crop seasons) should also be included in the 'Maintenance Fund' as an initial buffer, to encourage the concept of investing back into the next season, through buying inputs, technology and fertilisers etc.

2. *Provide climate-risk informed institutional capacity building support to 21 Irrigation Management Committees. This includes capacity building to DoI & ZINWA, in irrigation scheme design and maintenance, and to AGRITEX, to support management and climate resilient agriculture production*

Climate-risk informed institutional capacity building support should be provided to all irrigation schemes by DoI and AGRITEX, and supported by other organisations on the ground. The revitalisation of irrigation schemes marks a change in how communities need to collectively organise and manage themselves, to utilise impacts of the infrastructure and ensure its upkeep overtime. Interventions should consider the fact that communities may have already been involved with projects that have supported irrigation, and therefore this project should consider the specific successful and less-successful experiences of communities. Components of this support should include:

- Institutional capacity building support to IMCs to draft a Constitution and set-up a Maintenance Fund, to successfully operate and maintain the infrastructure
- Training and capacity building of farmers to operate and maintain the infrastructure (O&M), considering increasing climate change impacts, including pumping operation in highly variable flows
- Support from AGRITEX to Irrigation Management Committees (IMCs) to coordinate collective cropping choices, efficient pumping and irrigation scheduling based on climate change trends e.g. pumping scheduling in the occurrence of prolonged and intensifying mid-season droughts, and reinvesting revenue into scheme O&M (financial management)
- Support from DoI and ZINWA in upkeep and maintenance of the infrastructure in the face of a changing climate

While DoI has technical capacity and experience in implementing irrigation infrastructure, it will be important to increase capacity to 'climate-proof' infrastructure fit for small scale, rural usage, as well as in climate resilient O&M and agronomic practices (see section 6.4 below). In terms of long-term sustainability, this will allow planning and preparation to begin to implement climate resilient infrastructure at scale (in other target areas of the country). Similarly, AGRITEX has expressed the need for capacity building in support to farming as a business, which will support the maintenance of irrigation schemes.

3. *Provide solar power where appropriate as a sustainable energy source*

The Solar PV Viability Sub-assessment has found solar power to be a suitable form of power on small-scale, rural irrigation schemes. Solar power is sustainable in the long term because of low O&M costs, as well as the low skill requirement needed for its operation and upkeep. It also reduces high costs associated with running and maintaining diesel generators and achieves mitigation co-benefits. There is a growing private sub-sector that provides a variety of professional services in solar installation and upkeep, which is an important aspect to increasing the sustainability of solar investments. However, the Climate Resilient Irrigation Sub-assessment, recommends that solar should only be provided on up to 30ha on selected irrigation schemes[364]. This is because areas more than 30ha in size, licencing becomes a requirement and solar power is technically more challenging due to the size of PV array required to power the corresponding pumps. For sites with more than 30ha, it is recommended that the balance of the total irrigable area is powered from nearby (<3km), reliable grid supply.

### *6.2.2 Site selection*

A three-step methodology was used to select proposed sites for intervention.

**Collation of all known schemes**
DoI is the national authority responsible for all publically managed irrigation infrastructure, both in terms of identification and development. As such it has a full list of all known public irrigation schemes across the country under its Irrigation Masterplan. This list comprises of approximately 500 irrigation schemes. As a first step, the DoI's list was used to identify all known schemes across Runde, Save and Mzingwane catchments (Climate resilient irrigation sub-assessment). The irrigation schemes identified were then cross-referenced and supplemented where necessary by other sources, such as CRIDF's and the AfDB funded Shared Watercourse Support Project known irrigation schemes.

**Selection criteria developed**
Second, a selection criteria was developed in order to narrow down the 500+ existing schemes to a viable number for the proposed programme to target. Matrix based, multi-selection criteria were determined in order to select proposed schemes, mapping climate hazards using ZRBF's hazard maps, with vulnerability and availability of water sources, as well as considerations in size, land availability and a minimum number of beneficiaries (see Table 14). Criteria were validated by findings from the site visits and further consultations with stakeholders. It is important to note that the justification of one criterion overlaps with others, reflecting the holistic nature of the exercise and approach.

| | |
|---|---|
| 1. Size of irrigation scheme: between 20-<br>150ha (weighted 5%) | A size limitation of no less than 20ha and no more than 150ha has been selected, except in exceptional circumstances. This is because for the investment needed per scheme, less than 20ha would yield an impact that would not be on the scale required to achieve transformational change: the beneficiary size would most likely be below 40 households (see below), indirect beneficiaries would be limited, and the irrigation scheme would not tie into a 'river basin' approach easily, given its size. Any larger than 150ha would require a disproportionate amount of the budget, which would limit the ability of the overall project to intervene in areas across the three river basins in the southern provinces that are resident those who are the most vulnerable. Somewhere between 50-100ha would be the most ideal, to ensure value for investment is maximised according to size but with a distribution which allows areas across the three provinces to be targeted. This would result in between 50 and 100 schemes in total, to give an intervention area of 2 - 5,000ha across the three provinces. |
| 2. No. of beneficiaries: no less than 40 households (weighted 10%) | A household tally of no less than 40 per scheme has been selected, to be able to target resources in a way in which collectively results in the greatest impact across the southern provinces. Any fewer households would mean for the investment needed in the target area, resources would be less easily available to be disbursed throughout the three provinces. However, it is important to note that there is an exception to this is if there are fewer households with severe vulnerability (see below). Ideally, targeted areas are those that result in the maximum number of beneficiaries possible. |
| 3. Land availability (only | A public irrigation investment can only be implemented if a) land is available (hence land must be communally owned) and b) soil quality is sufficient for agriculture both now and under projected |

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| | |
|---|---|
| in communal areas) and soil suitability (weighted 15%) | climate change, given the impact of irrigation. No irrigation schemes are proposed for privately owned or managed lands. |
| 4. Water availability (weighted 40%) | Fundamentally, an irrigation scheme cannot be introduced in an area without available water, both now and under projected climate change, which creates the demand for irrigation. This criterion therefore receives the highest weighting at 40%. |
| 5. Vulnerability (weighted 20%) | The vulnerability of communities to climate change, or their lack of adaptive capacity, is one of the most important selection criteria, as in certain places over others, climate change impacts and poverty collide to produce vulnerability. The purpose of introducing irrigation schemes as a response to climate change is to reduce this vulnerability, and therefore communities in the most 'need' should be targeted, to the greatest extent possible. |
| 6. Readiness of communities (weighted 10%) | An important lesson learning in previous efforts (see Chapter 2) has indicated that a success factor includes the 'readiness' or willingness of communities to receive irrigation infrastructure and operate and maintain it overtime. Fundamentally, this includes their willingness to change their behaviour as a community in their approach to agriculture, including communally operating their lands and the infrastructure. This concerns the value they place on it, prior experiences and community power relations. A selection criteria concerning 'readiness' is therefore crucial to the success of the schemes and justifies, to a certain extent, the investment needed. |

Table 14: Irrigation scheme selection criteria.

**Application of criteria**
Thirdly, the above criteria were applied to the DoI's list of schemes to select between 50-100 schemes. Part of this process was screening potential sites against sites identified by other donor and public initiatives, in particular IFAD and FAO, to build on existing investments and prevent overlap. The list of target schemes was validated during the CRA package workshops with government officials.

| Mzingwane River Basin | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Entry no. | Name | Location coordinates | | Province | District | Irrigation System | Water Source | Irrigable area (ha) | Total area (ha) | Direct Beneficiary | Status | Remarks |
| M1 | Sebasa | 21°46'43.80"S | 29° 3'14.48"E | Matabeleland | Gwanda | Surface/ sprinkler | Tuli River | 60 | 60 | 100 | exist | Rehabilitation of wa supply, revitalise |
| M2 | Masholomoshe | 20°52'24.88"S | 29° 6'24.91"E | Matabeleland | Gwanda | Surface/ sprinkler drip | Masholomoshe Dam | 39 | 39 | 131 | exist | revitalise |
| M3 | Sukwe | 21°28'37.78"S | 29°18'1.09"E | Matabeleland | Gwanda | Surface/ sprinkler drip | Sukwe Dam. Boreholes | 28 | 22 | 44 | new | Develop from boreh source |

Table 15: Example of selected sites for the Mzingwane: location, irrigation system, water sources, irrigable areas, total areas, direct beneficiaries and current status.

Table 15 presents an example of the selected irrigation schemes which are presented in more detail per river basin in the irrigation sub-assessment report. A corresponding map (Figure 30) pinpoints the location of all schemes across the three river basins, as well as their location in relation to mid-season dry spells.

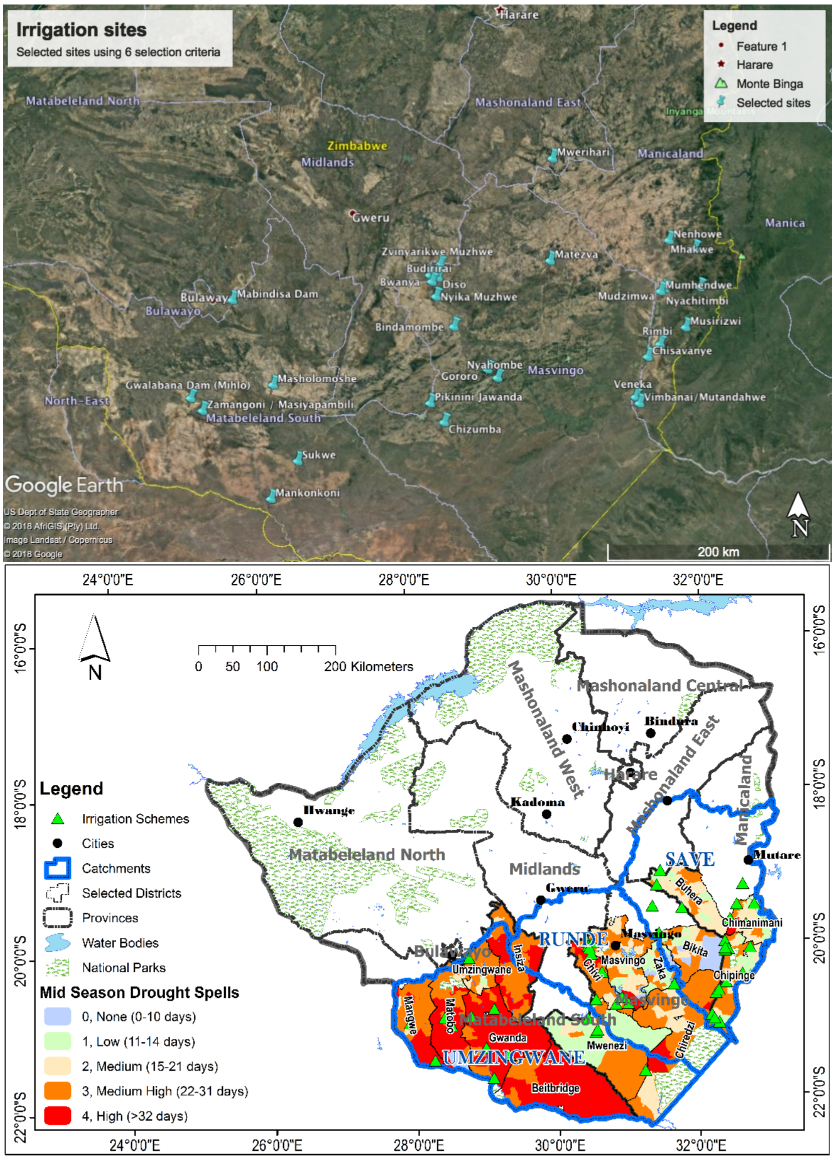



Figure 30: Locations of proposed irrigation schemes across southern provinces, mapped against mid-season dry spells. Source: ZRBF data

### *6.2.3 Infrastructure design*

Details are provided in the irrigation sub assessment report but it should be noted that the historical performances of the existing irrigation schemes in this proposal have been considered to ensure that the shortcomings that led to unsatisfactory scheme performance are adequately addressed. Irrigation schemes are highly case-specific; they are potentially complex and dynamic entities due to a range of factors that influence their effectiveness – including the type of natural resource base (water and soils), technology, scheme and plot size, farmer profile, location and access to markets and services. Diversity among schemes calls for different kinds of interventions to respond to varying farmers' needs and agricultural contexts. For example, revitalisation of existing schemes may see the conversion of canal schemes to pumped overhead sprinkler or drip systems. These revitalisation efforts must be designed to be viable on a financial level; it is critical that they achieve reasonable returns otherwise the outcomes will be unsatisfactory relative to investment and efforts. A key primary success factor is the infrastructure design.

Analysis of the various schemes, however, both existing and proposed, shows a number of similarities. The design for infield infrastructure follows standard methodologies – mainly sprinkler or drip. Flood irrigation is not recommended in the water scarce environments. The water supply pipelines are computed from the design volume / pressure for water required, resulting in a small range of pipe sizes being required due to the field size limitation. The total costs for infield irrigation and supply pipework is determined from unit costs for the conveyance infrastructure. The pumping gear requirements are determined from the volume and pumping pressure that gives the pump duty point. While this varies from site to site, it can be banded on the basis of type of motor and pump sets to supply the required water volume to the required pressure. The highest common cost driver for irrigation is the pumping gear. At this stage, for the production of preliminary designs and costings, the schemes have been categorised / banded based on the required pumping infrastructure. Schemes that have similar irrigation pump specifications and performance requirements (pump duty point) are grouped into one band. The pump/motor based bands also determine the power requirements. As detailed in the irrigation sub assessment report, the recommended power source is solar and this banding further assists in providing the solar power infrastructure required per site. The banding thus allows for computation of budget costings, as well as design of power supply requirements. The full list of sites and bands are provided in the irrigation sub assessment report, an example of which is shown in Table 16.

| | Name | Location coordinates | | Province | District | Irrigation System | Water Source | Irrigable area (ha) | Total area (ha) | Est Flow m3/hr | Head (m) | Band | Direct Beneficiary Households | Status | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| M1 | Sebasa | 21°46'43.80"S | 29° 3'14.48"E | Matabeleland | Gwanda | Surface/ sprinkler | Tuli River | 60 | 60 | 648 | 38 | 2 | 100 | Exist | Rehabilitation of water supply; revitalise |
| M2 | Masholomoshe | 20°52'24.88"S | 29° 6'24.91"E | Matabeleland | Gwanda | Surface/ sprinkler drip | Masholomoshe Dam | 39 | 39 | 421.2 | 43 | 1 | 131 | Exist | Revitalise |
| M3 | Sukwe | 21°28'37.78"S | 29°18'1.09"E | Matabeleland | Gwanda | Surface/ sprinkler drip | Sukwe Dam. Boreholes | 28 | 22 | 302.4 | 40 | 1 | 44 | New | Develop from borehole source |

Table 16: Example of sites categorised by band

### *6.2.4 Irrigation options analysis*

Per site, it is important to consider the most appropriate irrigation technology to be used under current and projected climate change and social and economic circumstances. In order to assess this, the following criteria can be usefully considered, and are elaborated on in more detail in the irrigation sub-assessment:

- Field size and shape;
- Topography;
- Irrigation efficiency;
- Cost;
- Labour/capacity;
- Management;
- Maintenance;
- Cropping type & schedules;
- Pressure requirements;
- Water quality, and
- Fertigation and chemigation capacity

The following technologies were considered for each site and evaluated based on each of the above considerations:

- centre pivots;
- flood irrigation;
- portable overhead sprinklers;
- gun systems (large volume sprinklers)

### *6.2.5 Climate proofing infrastructure*

Irrigation infrastructure should be designed to withstand both the current local climate as well as anticipated changes in rainfall and temperature, so as to provide a service for at least fifty years. A 'business -as-usual' design approach that only meets current regulatory requirements is no longer sufficient given the projected medium and long term impacts of climate change. Therefore, while it is clear that irrigation schemes can be extremely effective adaptation techniques for the target communities practicing subsistence agriculture in AER IV and V, it is critical that innovative and appropriate irrigation designs are proposed, to ensure the long term viability of the schemes.

In developing these designs, various aspects of the scheme must be considered with a view to optimising the resilience of the system. These include: the engineering design, the types of materials and technologies used, institutional arrangements, local capacity, access to markets, and financial and economic requirements (i.e. trade-offs between security of supply and cost). Decisions on how to build 'climate proof' infrastructure must also acknowledge the level of uncertainty that lies in the current climate projections (as discussed in Chapter 1) and allow for some level of flexibility in design. Some uncertainty cannot be avoided, but it can be dealt with by considering a range of futures and risk thresholds, and by identifying system sensitivities and working to build resilience to climate shocks (i.e. a proactive, rather than reactive, design approach). It is also critical that one takes into account lifespan, lifecycle maintenance costs and return on investment. The opportunity to build fit-for-purpose infrastructure only occurs at the start of the life of a new or replacement asset. A changing climate may mean that the ongoing functionality of existing infrastructure is compromised, forcing earlier investment and lower returns for existing investment.

Retrofitting to manage climate change impacts is generally costly and to be avoided if possible. For example - the cost of flood-proofing varies greatly and depends on the type and size of structure, local flood characteristics, and the necessary elevation to which the structure must be flood proofed. In general, it is less expensive to flood proof a new structure than an existing structure, and larger schemes have lower unit costs than smaller ones. Ultimately, it is imperative to understand the social, economic and environmental trade-offs of various technology options, and to reach a broadly-agreed position in the design of the protective facilities.

Many of the target sites visited it was evident that much of the infrastructure damage and deterioration was due to flooding, while siltation was prevalent in reducing dam storages. While it is not possible to mitigate the frequency or duration of this risk, adaptive design techniques that essentially protect the irrigation and related infrastructure should be employed. Methods of climate proofing infrastructure against floods include:

- River or watercourse bank reinforcement which involves adding material to the bank face to increase the bank stability and protection from river scour and erosion. These designs should withstand hydrostatic forces as well as train/direct floods.
- Bioengineering which refers to the use of plants or planting to stabilize the bank and increase the ability to resist scour by river and flood flows.
- Gabions which are wire-mesh baskets filled with locally available stones in block or mattress (flat) form. They can be stacked to form a stepped wall or can be laid on gentler slopes to form a surface covering for scour protection. The blocks are interlaced to form a flexible surface that resists erosive flood forces.
- Riprap/Geotextile which is an exposed layer of well graded stone or rock placed on a sloping bank face to resist erosive flood waters. A synthetic geotextile is usually placed between the riprap and underlying soil to act as a filter, thereby preventing the piping of soil through the rock and relieving hydrostatic pressure used to provide long term protection.
- Structure Anchoring where the structure is pinned and tied to a sound foundation to resist collapse and movement from hydro forces and scour.
- Installation of watertight closures which stops migration of water from one site to the other.
- Usage of sealants to reduces seepage through walls.
- Installation of check valves to prevent the backflow entrance of floodwater flows into utilities in a structure like a pump hose or power station.
- Above Flood Level Location of electrical, mechanical, and other equipment and contents will stop the equipment from being flooded.
- Diversions and rerouting of existing water course channel to divert excess storm water flow reduces flood risk and protects structures.

The design for flood protection in this instance has employed two methodologies, predominantly – Above Flood Level Location and Structure Anchoring with watertight structures where necessary. An allowance for appropriate erosion protection has been made in the design and costings. Figure 31 provides an example of a site-specific map with engineering design.

Figure 31: S2 Fari irrigation scheme, Chipinge District, Save Catchment.

Following this analysis, the energy source was selected based on viability considerations. Grid power deficit and its high operational costs dictated that on schemes with 30ha of irrigable land, solar panels are to be installed. For those with more than 30ha of irrigable land and within 3km from a reliable grid power source, grid connection would be installed. The energy installation costs were calculated as a lump sum according to irrigation scheme bandings.

### *6.2.6 Costing of component on climate resilient water supply*

The costing of climate resilient irrigation schemes is included below, with more details in the sub assessment. Indicative capacity building costs for IMCs, based on CRIDF's pilot projects experience as well as indicative capacity building costs for AGRITEX and DoI are included below.

The capex cost per hectare has been computed to include the preparatory planning, design, procurement and installation of the representative samples of each band of the irrigation schemes. This capex cost per hectare has then informed the expected irrigation scheme costs.

The costs have been categorised as to whether they can be seen as climate adaptation related incremental costs or typical baseline costs for irrigation schemes with no climate proofing measures. The capital costs of designing and constructing new and existing irrigation schemes to be flood proofed and water use efficient are categorized as climate proofing measures. Costs associated with supply of renewable energy for electricity are considered to be co-beneficial to climate mitigation. Costs involved with fencing of irrigated land, access roads, storage rooms and offices as well as supply of electricity from the grid are considered to be typical baseline costs. The averaged ratio between climate related incremental costs and baseline costs across irrigation schemes is 78% climate related costs and 22 % baseline costs, based on averaged ratio calculations across bands (Annex 23).

The average cost of irrigation infrastructure is estimated to be in the range of $3149 to $11,352 per hectare. The first represents a new scheme with new components from water abstraction to field application and the latter a revitalisation upgrade involving use of sprinkler or pivot systems and climate proofing of the existing infrastructure. It should be noted that retrofitting to manage climate change impacts is generally costly. In general, it is less expensive to flood proof a new structure than an existing structure.

The total development of approximately 21 irrigation schemes, comprising of 1,786 ha and targeting roughly 5,899 direct beneficiary households, is estimated to cost $14,4 million dollars.

| Name | Catchment | District | Band | Water Source | Irrigable area (ha) | Direct Beneficiary Households | Status | Ha / Beneficiary Households | Irrigation scheme costs | Solar costs | Electrification costs | Total scheme cost incl. solar and electrification | Cost per beneficiary | cost per ha |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Gwalabana Dam (Mihlo) | Mzingwane | Matobo | 1 | Dam | 22 | 600 | Existing | 0.036666667 | 203500 | 75000 | | 278500 | 464 | 12659 |
| Mabindisa Dam | Mzingwane | Umzingwane | 1 | Dam | 30 | 630 | Existing | 0.047619048 | 277500 | 150000 | | 427500 | 679 | 14250 |
| Mankonkoni | Mzingwane | Beit Bridge | 1 | Tuli River | 40 | 100 | Existing | 0.4 | 370000 | 150000 | 20000 | 540000 | 5400 | 13500 |
| Masholomoshe | Mzingwane | Gwanda | 1 | Masholomoshe Dam | 39 | 131 | Existing | 0.297709924 | 360750 | 150000 | 20000 | 530750 | 4052 | 13609 |
| Zamangoni / Masiyapambili | Mzingwane | Matobo | 1 | Dam | 20 | 40 | New | 0.5 | 185000 | 75000 | | 260000 | 6500 | 13000 |
| Bindamombe | Runde | Chivi | 1 | Bindamombe Dam | 34 | 300 | Existing | 0.113333333 | 277500 | 150000 | | 427500 | 1425 | 12574 |
| Bwanya | Runde | Masvingo | 3 | Shashe River | 150 | 300 | Existing | 0.5 | 1453500 | 150000 | 80000 | 1683500 | 5612 | 11223 |
| Chizumba | Runde | Chivi | 2 | Mwenezi river | 65 | 250 | Existing | 0.26 | 601250 | 150000 | 60000 | 811250 | 3245 | 12481 |
| Gororo | Runde | Chivi | 3 | Tokwe Mukosi | 120 | 240 | New | 0.5 | 277500 | 150000 | | 427500 | 1781 | 3563 |
| Matezva | Runde | Masvingo | 1 | Matezva Dam | 20 | 100 | Existing | 0.2 | 185000 | 75000 | | 260000 | 2600 | 13000 |
| Nyahombe | Runde | Chivi | 4 | | 200 | 300 | New | 0.666666667 | 277500 | 150000 | | 427500 | 1425 | 2138 |
| Pikinini Jawanda | Runde | Mwenezi | 4 | Manyuchi Dam | 200 | 300 | New | 0.666666667 | 277500 | 150000 | | 427500 | 1425 | 2138 |
| Zvinyarikwe Muzhwe | Runde | Chivi | 3 | Muzhwe Dam | 150 | 300 | New | 0.5 | 277500 | 150000 | | 427500 | 1425 | 2850 |

| Name | Catchment | District | Band | Water Source | Irrigable area (ha) | Direct Beneficiary Households | Status | Ha / Beneficiary Households | Irrigation scheme costs | Solar costs | Electrification costs | Total scheme cost incl. solar and electrification | Cost per beneficiary | cost per ha |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Mhakwe | Save | Chimanimani | 1 | Munyanyadzi River | 20 | 50 | Existing | 0.4 | 185000 | 75000 | | 260000 | 5200 | 13000 |
| Mudzimwa | Save | Chipinge | 1 | Tanganda Boreholes | 20 | 60 | Existing | 0.333333333 | 185000 | 75000 | | 260000 | 4333 | 13000 |
| Musirizwi | Save | Chipinge | 2 | Gambadziya River | 60 | 200 | Existing | 0.3 | 555000 | 150000 | 60000 | 765000 | 3825 | 12750 |
| Mwerihari | Save | Buhera | 1 | River | 21 | 210 | New | 0.1 | 194250 | 75000 | | 269250 | 1282 | 12821 |
| Nyachitimbi | Save | Chipinge | 1 | Nyamachitimbi River | 18 | 60 | Existing | 0.3 | 166500 | 75000 | | 241500 | 4025 | 13417 |
| Rimbi | Save | Chipinge | 4 | Save River, 15km pipeline | 500 | 1600 | Existing | 0.3125 | 4695500 | 150000 | 120000 | 4965500 | 3103 | 9931 |
| Veneka | Save | Chipinge | 1 | Save river sand abstraction | 30 | 60 | Existing | 0.5 | 277500 | 150000 | | 427500 | 7125 | 14250 |
| Vimbanai/Mutandahwe | Save | Chipinge | 1 | Save River | 27 | 68 | Existing | 0.397058824 | 249750 | 75000 | | 324750 | 4776 | 12028 |

| | Sum of Irrigation scheme costs | Sum of Solar costs | Sum of Electrification costs | Sum of Total scheme cost incl. solar and electrification | Sum of Direct Beneficiary Households | Sum of Irrigable area (ha) |
|---|---|---|---|---|---|---|
| **Totals** | 11532500 | 2550000 | 360000 | 14442500 | 5899 | 1786 |

### 6.2.7 *Training of Irrigation Management Councils*

A key component of the project is to ensure adequate training of Irrigation Management Councils to ensure smooth operation and maintenance of the climate resilient irrigation infrastructure as well as the generation of funds to secure the schemes ongoing maintenance. The indicative unit costs for training of IMCs for all proposed irrigation schemes are shown below.

| Costs for IMC training | Delivery Method | Total Cost in USD per Scheme |
|---|---|---|
| Constitution drafting | 2-3 day Facilitated training Training Workshop. Government agencies to provide continous training | 2,000 |
| Climate risk informed O&M training | 2-3 day Facilitated training Training Workshop. Government agencies to provide continous training | 2,550 |
| Climate smart irrigation and cropping scheduling – in connection with FFS | 1-2 day Facilitated training Training Workshop. Government agencies to provide continous training | 2,200 |
| Setup of maintenance fund, market analysis and irrigation scheme business plan | 2-3 day Facilitated training Training Workshop. Government agencies to provide continous training | 2,000 |
| Travel for AGRITEX & DR&SS experts | Per scheme for trainings | 1,400 |
| DSA for AGRITEX and DR&SS experts | Per scheme for trainings | 2,000 |
| **Total** | | **12,150** |

It is also proposed to support networking activities between the IMC's to support peer learning and uptake of new climate smart practices.

| **Number and timing of investments through out project period** | | Year / Season 1 & 2 | Year/ Season 3 & 4 | Year/ Season 5 & 6 | **Total number of meetings** | **Total cost** |
|---|---|---|---|---|---|---|
| | Unit cost in USD | Number | Number | Number | Number | Cost in USD |
| IMC networking - Provincial level peer meetings and training for targeted irrigation schemes, per season | 8175 | 3 | 3 | 3 | **9** | **73575** |

### 6.2.8 *Capacity building of AGRITEX and DoI staff to support Irrigation Management Councils*

There is also a need to provide capacity building of AGRTEX and DOI to support IMC's in O&M as well as water efficient irrigation scheduling. While DoI is tasked with overall, national and provincial level coordination and management of irrigation development in the country, AGRITEX staff at the local level are often responsible for supporting IMCs and farmers groups in irrigation schemes. AGRITEX however is more skilled on the agronomic practices than on the O&M of irrigation schemes and will also need training in terms of promoting the most climate smart and water efficient irrigation practices. Based on this training, it is expected that both AGRITEX and DoI will have sufficient in house competences to cover training needs for IMC's for the full project period.

The capacity building needs and estimated costs are shown below.

| **Capacity building of AGRITEX and DoI through out project period** | | Year / Season 1 | | Year 2 / Season 2 | | **Total** |
|---|---|---|---|---|---|---|
| **Capacity building actions** | Unit cost in USD | Number | Cost in USD | Number | Cost in USD | Cost in USD |
| Training of 52 AGRITEX district level, 6 provincial level DoI and AGRITEX staff on Climate resilient irrigation O&M and climate smart irrigation scheduling. Cost per provincial training of 20 persons | 8450 | 3 | 25350 | 3 | 25350 | 50700 |
| Annual review meeting for 52 AGRITEX district level, 6 provincial level DoI and AGRITEX staff on Climate resilient irrigation O&M and climate smart irrigation scheduling. Cost per provincial training of 20 persons | 8450 | 3 | 25350 | 3 | 25350 | 50700 |
| **Total cost** | | | | | | **101400** |

## 6.3 Strengthened capacity of smallholders to implement climate-smart agricultural production

This study recommends **scaling up Climate resilient agriculture (CRA) among rain-fed and irrigation farmers** across the southern provinces. Synergising with existing efforts and supporting GoZ's ZAIP (2013-2018), smallholders will be supported to adopt and implement **CRA packages**. Within the packages, CRA practices will focus on increased water resource management efficiency, increasing agricultural production on irrigation schemes in horticulture crops, and supporting sesame and sorghum production on drylands. Irrigation and rain-fed farmers will also be encouraged to adopt climate-adaptive practices for livestock rearing, such as raising of drought tolerant livestock breeds, water harvesting, fodder production, and hay making using irrigated crop residue. The CRA packages should be implemented through **Farmer Field Schools**, a tried and tested methodology in Zimbabwe. FFS's will work in tandem with **Innovation Platforms**, which focus on developing market linkages, out-scaling best practices into the AGRITEX extension service and upscaling of innovative resilience building efforts through policy circles. The project should build the capacity of AGRITEX in CRA best practice and adaptive knowledge management, complementing and building on the efforts of ZRBF. The knowledge and experience gained as part of CRA implementation through FFS and Innovation Platforms should be out-scaled through the AGRITEX extension service to smallholders. This also entails that lessons learned from CRA practice are fed into the training of AGRITEX Officers, through learning materials and easy to access information circulars, exchange visits, and other means of internal capacity building.

### 6.3.1 *Tailored, site-specific design of CRA packages*

The design of tailored, site-specific CRA packages has followed a methodology comprising of a targeting exercise in the target project area based on analysis of climate vulnerabilities (see Section 1.7) and a number of consultations with key stakeholders, comprising of validation workshops with government officials, including representatives from DR&SS and AGRITEX, and community Focus Group Discussions. A model for climate resilient agriculture packages has been developed informed by analysis of baseline and past experiences in introducing climate-smart agriculture in Zimbabwe, the proposed high-impact crop-livestock combinations identified in the value chain study for the project, other high-impact crop-livestock combinations and CRA practices identified through desk study and conversations with key actors, the proposed number and location of irrigation schemes as per the sub assessment for the project, the business challenges faced by farmers and possible solutions for linking up with markets and a number of ad hoc consultations with key stakeholders. On this basis, the study provides a set of recommendations and costed CRA package options to inform the project design.

As a first step, suitable value chains were identified, (see Table 17) as high impact potential crop and livestock opportunities based on criteria such as: ready markets; potential for establishing market linkages with key market actors in identified value chains; climate resilience potential of the crop/livestock option; and potential for decreasing poverty and food insecurity.

| **Proposed Value chains** | **Justification** |
|---|---|
| **Irrigated horticulture**<br>- Irrigation schemes | Irrigation removes the risk of rain failure during the rainy season and allows for cultivation in dry season. High profitability, depending on horticultural product.<br><br>High impact horticultural products were selected through the VUNA sub assessment of potential high impact value chains and the possible support from AGRITEX workers at the national, provincial and district level. Focus was on **commercial crops** which were selected for high value per hectare, existing production skills, low perishability, well defined markets and formal and informal unmet market demand. The study also concluded that there is **scope to expand and complement** these products as variety is one of the key competitive advantages mentioned by buyers. |
| **Sesame**<br>- Dry land farmers | New crop, but well suited to Zimbabwean climate and agricultural systems. Drought tolerant and grows under rain fed farming. Low cost of inputs with a good rate of return. High impact and income potential for smallholder farmer, with e.g. WHH under ZRBF demonstrating success. |
| **Small grains**<br>- Dry land farmers | Drought resistant alternative to maize. The most reliable cropping option for food security and good nutrition value. Low cost in terms of input. Potential for diverse value addition. Existing research expertise in both government departments, NGO's and among research institutions such as ICRISAT. |
| **Livestock**<br>– Cross cutting. In combination with irrigation and dryland farming. | Critical element of farming systems in the three provinces and socio-cultural priority. High level of livestock management knowledge, livestock research expertise in government departments, NGO's and among research institutions such as ICRISAT. Some basic value chain infrastructure present. Research from ICRISAT in collaboration with government departments indicate that a combination of crops and livestock is most effective for small holder farmers. |

Table 17: Proposed agricultural value chains.

The selection of these value chains was based on stakeholders' perception of the appropriateness of the crop-livestock combination for each area vis a vis climate risks, the ease of value chain development towards increased climate resilience, potential for building on existing initiatives and good practices, and socio-cultural norms and preferences among smallholder farmers. For instance, for horticulture, it was argued that fruit production, such as banana and citrus, required long-term investment, which smallholders would find difficult to commit to. It was therefore recommended to focus on more ‘low hanging’ opportunities, such as seasonal horticulture crops, low cost sesame investments, and well-known value chains such as small grains and livestock, where some developments have already taken place.

The high potential crops-livestock combinations and suitability of the proposed crop/livestock value chains were validated with key stakeholders and matched with the targeted areas. Table 17 and Figure 32 show the validated overview of suitable crops and markets per district.

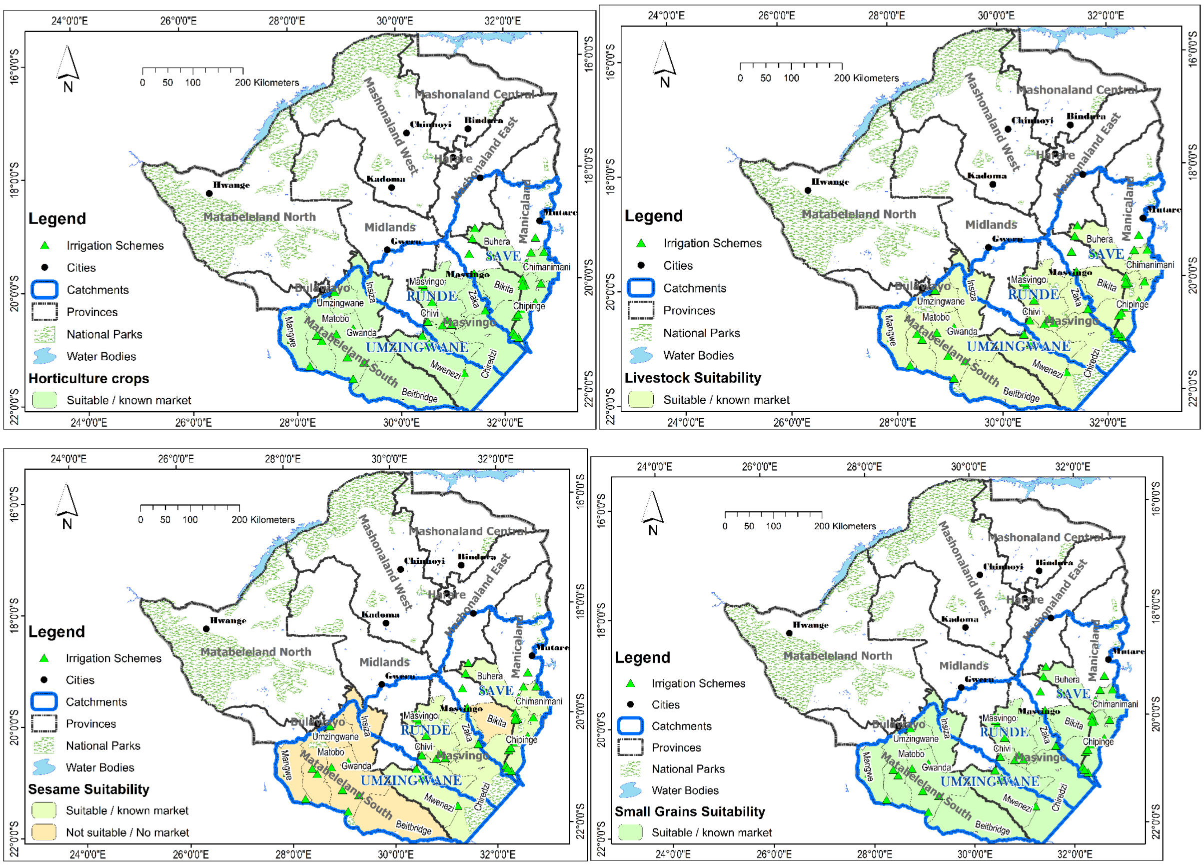



Figure 32: Proposed sites for CRA packages, and suitability of horticulture, sesame, small grains and livestock.

Table 18: Overview of suitability of crop-livestock combinations per district and identified markets[365]

Suitable / known market

Unknown or partial suitability/ Unknown market

Not suitable / No market

| | District | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Horticulture crops** | **Buhera** | **Chimanimani** | **Chipinge** | **Bikita** | **Zaka** | **Chivi** | **Chiredzi** | **Masvingo** | **Mwenezi** | **Beit-bridge** | **Gwanda** | **Insiza** | **Mangwe** | **Matobo** | **Umzingwane** |
| Horticulture crops | | | | | | | | | | | | | | | |

[365] As validated through provincial workshops with provincial and district level AGRITEX, DoI staff, district level farmers groups and local research/academic actors, June 2017. A more detailed list of proposed market players is included in the consultation records.

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Horticulture – Fruits** | | | | | | | | | | | | | | | |
| Banana | | | | | | | | | | | | | | | |
| Citrus | | | | | | | | | | | | | | | |
| **Small grains** | | | | | | | | | | | | | | | |
| Div. small grains | | | | | | | | | | | | | | | |
| Livestock | | | | | | | | | | | | | | | |
| **Sesame** | | | | | | | | | | | | | | | |
| Sesame | | | | | | | | | | | | | | | |

During the consultations, the approach to developing and targeting site-specific CRA packages was validated by stakeholders, with some adjustments based on AGRITEX experience. The recommendations on high potential crops (horticulture, small grains and sorghum, livestock and sesame) and the promotion of market linkages through contract farming from the Value Chain Sub-assessment were confirmed, with the recommendation to take an integrated approach to small grains and livestock production in the dry areas, creating a single package for both of them. CRA packages on the selected horticulture crops for irrigated areas, sesame production for dry land areas and small grains and livestock were designed.

Through stakeholder consultations, CRA packages were tried and tested, as well as new CRA practices, were proposed based on: drought tolerant crop varieties and livestock breeds; improved crop varieties; intercropping and incorporation of trees and shrubs into cropping systems; use of poly cultures and crop diversification; moisture saving tillage techniques; integrated crop livestock systems; improved water resource management for both dry land and irrigated land – e.g. through conservation agriculture; and efficient irrigation systems. These are summarized below for each of the value chains, and will be applied to sites at which the value chains are relevant, as shown above:

**Climate-resilient practices for horticulture:**

- Climate resilient practices related to the selected horticulture crop – contributing to water conservation and soil fertility
- Efficient use of inputs, e.g. fertilizer and efficient use of water through efficient irrigation practices, e.g. drip irrigation, centre pivot and irrigation scheduling.
- Integrated production and pest management, including soil fertility management through crop rotation, intercropping and agroforestry options, mulching, use of crop calendar and other techniques with a focus on improving soil structure and managing the land sustainably.
- Post-harvest management and improved storage for crops – in cooperation with private sector players

**Climate-resilient practices for small grains production in small grains and livestock-suitable districts:**

- **Efficient use** of inputs, such as drought resistant, improved seeds, fertiliser, manure and water.
- **Minimum tillage:** Land preparation through minimum soil disturbance, planting stations, basins, ripping, direct seeding, as per CA principles
- **Crop rotations:** Climate-smart choice of crop – both improved and drought tolerant indigenous varieties. Use of crop mixing and rotation – e.g. small grains, legumes and cash crops rotation and application of agro-forestry, where possible and beneficial
- **Soil cover:** Provision of soil cover through mulching
- **Integrated production and pest management:** This includes soil fertility management and other techniques with a focus on improving soil structure. Limited use of pesticides, if any.
- **Promotion of crop-livestock interaction**
- **Post-harvest management** and **storage**

**Climate-resilient practices for livestock production:**

- **Improved management** of rangelands, paddocks, re-planting of pastures building on experiences from Matobos research station/ ICRISAT, Practical action in Gwanda and SCCA in Chiredzi. Guidance on improved stock management taking into account carrying capacity of land.
- **Fodder production,** supplementary feeding, pen fattening, feedlots, water provision. Agro forestry may play a role here.
- Linkages to climate-smart **crop production of small grains and other crops**

- Provision of advice on general **livestock management,** including breeding practices, dip tanks, veterinary services

**Climate-resilient practices for sesame production:**

- **Efficient use** of inputs, such as drought resistant, improved seeds, fertiliser, manure and water.
- **Minimum tillage:** Land preparation through minimum soil disturbance, planting stations, basins, ripping, direct seeding, as per CA principles
- **Crop rotations:** Use of crop mixing and rotation – e.g. rotation of sesame with small grains and legumes and application of agro-forestry and crop-livestock interaction principles, where possible and beneficial
- **Soil cover:** Provision of soil cover through mulching
- **Integrated production and pest management:** This includes soil fertility management and other techniques with a focus on improving soil structure. Limited use of pesticides, if any.
- **Post-harvest management**

The practical implementation of the CRA solutions in each district will allow for f**lexibility in the choice of crops and practices** based on farmers interests and preferences, as well as options for market linkages and value chain development. This is important as farmers' options, assets and target crops and livestock may change before project inception. Further CRA package development during the project will also use the CRA manual for training of AGRITEX Extension Officers, as well as the growing body of evidence on CRA practices and resilience building gathered under ZRBF.

Based on the findings and learnings in undertaking the targeting and validation exercise to result in site-specific CRA packages, and the best practice, lessons learned, gaps and barriers analysis as summarised in previous chapters of this study, **key recommendations** to implementing CRA packages are presented below.

1. *Implement targeted, site-specific CRA packages to ensure cost-effective uptake of climate smart agricultural crop and livestock production among smallholder farmers, especially women, through a connected structure of Farmer Field Schools and Innovation Platforms*

While a detailed targeting exercise has been undertaken at a district and ward level (see chapter 1), it is recommended that the project carry out an updated, participatory targeting at the outset of project implementation. This should be based on representative communities at for each target area, in order to consider new interventions in each district between now and the time of implementation. The targeting exercise will establish links and synergies with local authorities, CSOs operating in the areas, government partners, and locally present market actors that may best be leveraged – as well as serve as a baseline study, that ensures results may be measured against over the lifetime of the project. The final ranking and selection system for targeting districts and wards should include:

- **Most climate vulnerable wards:** Application of climate and vulnerability analysis from recent climate risk monitoring to target the most climate vulnerable districts, mainly in relation to risk of mid-season dry spells, droughts and other extreme events.
- **Potential for synergies:** Updated analysis of potential for synergising and complementing similar project interventions, including ZRBF interventions, avoidance of overlaps and duplication of efforts, and opportunity to build on the Scaling Up Adaptation project and other investments. Local community initiatives should be considered.
- **Ownership:** Analysis of target populations' social and economic vulnerabilities and capabilities, their level of organization and ability and willingness to engage actively in project interventions, based on the expectation that ownership of and investment of own time and resources in interventions is key to ensure sustainability.
- **Market linkages and value chain development potential:** Updated assessment of potential for facilitation of market linkages for entry into value chains, including access to market infrastructure, suitability of suggested value chains and local market actors.

The introduction of CRA practices and climate resilient crop and livestock breeds hinges on **effective models for learning and uptake** among smallholders, as well as market linkages and training on 'farming as a business' to ensure smallholders are integrated into the agricultural economy. Analysis of lessons learned and consultations with AGRITEX and DR&SS has resulted in a recommendation that a combination of Farmer Field Schools and Innovation Platforms would be effective and provide a sustainable impact at a local level, as well as a network by which to scale out CRA methods and climate-smart crops through the national extension service. It is therefore recommended that the project employs a mix of Farmer Field Schools and Innovation Platforms to support adoption of climate resilient agricultural production and facilitate smallholder inclusion into markets overtime through developing nascent market linkages. Learning from ICRISAT experience shows that Innovation

Platforms and FFS are interventions that needs to be used strategically to produce sustainable outcomes that can be scaled out and up in a cost-effective manner. It is recommended that the project increases the likelihood of sustainability and geographical coverage of the CRA interventions by scaling up the successful practices from the district and provincial level FFS to the national level. At the national level, this structure is recommended in order to influence the development of policies and national frameworks for promotion of CRA among smallholders based on evidence and experience from practice. Likewise, it is recommended to scale out successful CRA promotion approaches through public and private extension services[366], through Agricultural Training Colleges and lessons learned publications based on experiences developed through Innovation Platforms. In order to **institutionalize the adaptive management of farming practices and value chains,** it is recommended that Innovation Platforms are hosted within DR&SS and AGRITEX institutions, with support from external resources in the relevant provinces/districts and the contribution of Agricultural Training Colleges.

The proposed model of FFS and Innovation Platforms is shown below (presented in more detail in the CRA Sub-assessment). The idea is that FFS each targeting a group of 30 lead farmers are carried out over 2 seasons, during which the lead farmers are guided through the production cycle, growing climate smart crops and raising livestock with CRA methods. Representatives from farmers associations participate in Innovation Platforms to provide smallholder perspectives and experiences in developing market linkages, facilitating smallholder access into the market and developing relationships with relevant market players. This should allow for practical experience from the smallholder producer level to feed into market linkage development and support adaptive management of production and marketing to consider climate risks[367,368]. Similary, the work of Innovation Platforms will inform FFS's. Following two seasons of working with the same FFS group, AGRITEX Extension Officers and lead farmers may out-scale the demonstration of climate smart production to other farmers and communities, setting up demonstration plots and showing by example how commercial, high-value, climate smart production and collective engagement with markets increase farmers' incomes.

Table 19 and Table 20, below, shows the proposed levels of Innovation Platforms, links between platforms and links to Farmer Field Schools and phasing of interventions

Table 19: Innovation Platform structure

| Level | Key Institutions | Structure | Focus |
|---|---|---|---|
| National and provincial level | AGRITEX<br>DR&SS<br>Provincial and district level stakeholders' representatives<br>Private sector representatives<br>National level decision makers<br>Farmers associations representatives | Upscaling and out-scaling platform | Focus: Integration of experiences and innovations in national level policies, in DR&SS and AGRITEX capacity building efforts, out-scaling through AGRITEX extension work<br>Links: Link to district level platforms. |
| District level | Research institutions (Facilitators)<br>AGRITEX and Department of Livestock at district and provincial level<br>AGRITEX colleges<br>DR&SS research stations<br>Farmers associations / groups reps<br>Private sector players across each value chain<br>RDC, DA and other local decision makers | Sesame IP cluster<br>Horticulture IP<br>Small grains-Livestock IP | Focus: Identify problems/ challenges and find solutions to how best to integrate smallholder farmers in value chains across three provinces and 3 types of climate smart value chains. The innovation platforms build on experiences from FFS and feed identified solutions into FFS practice across the three provinces. The innovation platforms may also influence district level decision making to promote solutions.<br>Links: Link to FFS at ward level, other innovation platforms across districts, national level upscaling-out-scaling platform. |

[366] This may include approaches such as Farmer Field Schools, demonstration plots as well as other approaches to spreading the message – e.g. through mobile-phone based weather and farming information system – as described in the climate information sub assessment.
[367] E-mail correspondence with DR&SS, director of crops. Validation of suggestion in CRA consultation workshop 2nd of May and 6-8th of June 2017.
[368] Braun et al. (2006). A Global Survey and Review of Farmer Field School Experiences

| | | | |
|---|---|---|---|
| Ward level | AGRITEX at district and ward level<br>Lead farmers | FFS with 30 Lead Farmers | Focus: Train 30 Lead Farmers from 5-10 communities in relevant CRA and CA practices, farming as a business related to the particular crop-livestock combinations and facilitate links to markets/private sector.<br>Links: Link to district level innovation platform |
| Communities | AGRITEX at district and ward level<br>Lead farmers<br>Communities / beneficiary farmers | Peer learning in communities | Focus: Lead farmers inspire and teach other farmers in own communities to take up climate resilient agriculture practices<br>Links: Link to FFS at ward level |

Table 20: Innovation platforms and phases of interventions

| **Level** | **Structure** | **Phasing of interventions** | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | **Y1** | **Y2** | **Y3** | **Y4** | **Y5** | **Y6** | **Y** |
| National level | Upscaling and outscaling platform | | | | | | | |
| District and provincial level | Sesame IP cluster, Horticulture IP<br>Small grains-Livestock IP | | | | | | | |
| Ward level | FFS with 30 Lead Farmers | | | | | | | |
| Communities | Peer learning in communities | | | | | | | |

2. *Build the capacity of DR&SS, AGRITEX Extension Officers and Agricultural Training Colleges in CRA practices to train lead farmers in FFS, as well as to disseminate CRA best practices and learning*

One of the key aspects in rolling out CRA packages is to address capacity building needs of AGRITEX, DR&SS and Agricultural Training Colleges on CRA, as expressed during consultations and identified in the barrier analysis. This should include capacity building to analyse climate change vulnerabilities, relevant CRA practices and climate smart crop/livestock combinations. The CRA package consultations also identified a need to strengthen knowledge management systems and practices, both in terms of human resources and knowledge management equipment. This should contribute to ensuring that the best methods of adoption and most suited CRA practices are replicated at scale, and that there is a continual adaptation and innovation of approaches according to evolving climate change.

At the level of the FFS, the CRA packages should include:

- Participatory analysis of changes in farming calendars and use of climate information systems and seasonal forecasts to plan for the season
- Participatory analysis and choice of climate smart crops with market potential, particularly for irrigation schemes
- Training in CRA practices relevant to selected climate smart crops, varieties and livestock breeds
- Improved water resource management for both dry land and irrigated land: Efficient irrigation and water management practices, soil moisture conservation through mulching and reduced tilling
- Appropriate tilling approaches, soil management that conserves carbon, restoration of degraded lands, efficient use of fertilizer
- Potentials for agro-forestry and incorporation of multipurpose trees and shrubs into cropping systems. Linked to integrated crop livestock systems.
- Integrated production and pest management
- Improved post-harvest management and storage for crops, considering climate risks.

At the level of the Innovation Platform, the CRA package should include:

- Participatory analysis of successful climate smart agricultural practices, level of adoption of practices and varieties/breeds among participating farmers and in community, analysis of changes in yields and income levels with a wide range of stakeholders, incl. private sector and small holder farmers

- Capacity building of farmers associations / commodity associations through Innovation Platforms based on needs assessment for how to support uptake of CRA crop-livestock combinations and practices

In terms of capacity building of AGRITEX officers, it will be key to:

- Build capacities of AGRITEX officers through in-service training in the above mentioned CRA practices and crop-livestock combinations as well as general concepts of climate resilient agriculture and climate smart landscape management.
- Build capacities of coming AGRITEX officers through Agricultural Training Colleges and provision of learning materials in the above mentioned CRA practices and crop-livestock combinations as well as general concepts of climate resilient agriculture and climate smart landscape management.
- Utilize DR&SS research centres and Agricultural Training Colleges as learning spaces and knowledge and demonstration centres for CRA
-

It is recommended that capacity building efforts within AGRITEX are rolled out through training of a group of national and provincial level master trainers within DR&SS and AGRITEX, who may then cascade trainings to Innovation Platforms, district and ward level AGRITEX Extension Officers, AGRITEX teachers and students as well as develop training materials and guides for CRA.
Utilizing the DR&SS's existing research centres and Agricultural Colleges (see Chapter 2) as knowledge management centres is feasible, but it is pertinent to note that especially the DR&SS research stations normally work on specific crops/livestock - and often they are far from the wards where extension officers are working from (see Annex 11 for DR&SS research stations and their focus areas and annex 12-14 for past and ongoing research related to climate change adaptation). Hence, accessibility of information from such centres need to be prioritised.

#### *6.3.1.1 Costing of CRA component*

CRA packages for horticulture, sesame, and integrated small grains and livestock, which comprise of the relevant CRA practices required, and inputs for a demonstration plot, for farmers to experience and apply, are costed in the table below, with complementing capacity building costs for AGRITEX training on CRA detailed further below.

| **Indicative unit costs for Farmer Field Schools** | |
|---|---|
| **Type of FFS** | Unit cost USD |
| FFS Small grains and livestock | 3800 |
| FFS Horticulture | 3180 |
| FFS Sesame | 1780 |

Costing for Farmer Field Schools are based on the explanations of how a Farmer Field School will function (see section 5.2.2 Farmer Field Schools and demonstration plots) and practical experience, namely OXFAM experiences from the Scaling Up Adaptation project and Welt Hunger Hilfe and MELANA interventions under ZRBF.

Costing for a farmer field school include fencing for a demo plot, implements and inputs, complete soil analysis testing and refreshments for the first training during a season. It also includes look and learn visits for farmers to learn about a particular CRA method or crop-livestock promoted by another FFS as well as open community days for the wider community to learn from the FFS.  Detailed calculation of costs per Farmer Field School are presented in the CRA sub assessment.

Farmers are also expected to contribute to refreshments for meeting throughout the FFS, except for the first FFS training at the start of the season, and to also put in labour for the demonstration plot and facilities.

Farmers are expected to source inputs for own fields in the long run, through facilitation of contract farming agreements as part of the FFS and innovation platforms. Experiences and evaluation of the conservation agriculture programme showed that when farmers received input packages free of charge, the impact was not sustained to that same extent as the farmers who themselves invested in inputs. The project may therefore consider to provide or facilitate matching investments to support inputs, fertilizer, technical assistance to get farmers started and get the financial basis for small scale commercial production - provided that farmers themselves are willing to invest an equal amount in increasing productivity. Through farmer field schools and innovation platforms the project will then facilitate contract farming agreements to ensure long term contract / business relationships with private sector, through which input, agronomic support and a formalised market is provided to guarantee consistent revenue generation. As demonstrated through the Scaling Up Adaptation project, smallholder farmers who grow horticulture products have good opportunities for entering into contract farming and multipartite arrangements with private sector players and micro finance institutions – facilitating loans for input and productive investments and ensuring a ready buyer for produce. For sesame and small grains and livestock, farmers may have to make productive investments to attract interested private sector players and based on Scaling Up Adaptation project experience, it is recommended to support farmers production, through matching investments to the collective of lead farmers engaged in farmer field schools.

Table 17: Indicative unit costs for matching investments for Farmer Field Schools

| **Matching investments for seed, fertilizer and similar per lead farmer over 2 seasons** | | |
|---|---|---|
| **Type of FFS** | Unit cost in USD per FFS (2 seasons) | Unit cost in USD per farmer for the project |
| FFS Small grains and livestock | 2250 | 75 |
| FFS Horticulture | | |
| FFS Sesame | 1500 | 50 |

### 6.3.1.2 *Indicative costs for CRA investments related to gender equality*

In order to address gender inequalities in agriculture, the project may invest in capacity building for both agricultural and technical services extension workers as well as communities.

The project may draw on successful methodologies such as the Gender Action Learning System which OXFAM has successfully implemented through the Livelihoods and Food Security project in Zimbabwe with a focus on women empowerment as well as gender equality. This includes training in farming as a business and participatory and gender sensitive market and value chain analysis, with a focus on identifying value chains which are traditionally relevant to women or new, in which women may gain foothold. The strengthening of womens farming and business may take a starting point in existing saving and loans groups or similar groups, that are already interested in and able to work together. Value chain development is to be supported through innovation platforms. Also, the GALS methodologies aim to include both men and women in the work towards gender equality through training as gender equality champions. Other interventions to make agricultural extension services and promotion of market linkages more gender sensitive and gender equal include Technoserve, which has provided good examples of women business leadership training and female-led business ventures.

| **Number and timing of gender equality investments through out project period** | | Year / Season 1 & 2 | Year/ Season 3 & 4 | Year/ Season 5 & 6 | **Total number** | **Total cost** |
|---|---|---|---|---|---|---|
| | Unit cost in USD | Number | Number | Number | Number | Cost in USD |
| Womens economic leadership training for AGRITEX and DR&SS trainers team - 3 days, 30 persons | 17625 | 1 | 1 | 1 | **3** | 52875 |
| Training of ward, district and provincial level staff (by trained trainers, from capacity building, above) on specific CRA related topics (30 persons, per province) | 8800 | 3 | 3 | 3 | **9** | 79200 |
| Study of climate smart market and value chain development opportunities with a specific focus on women involvement and design of training interventions | 20000 | 1 | | | **1** | 20000 |
| Gender equality champion workshop (3 days, 30 persons, per ward, 2 seasons) | 750 | 30 | 60 | 47 | **137** | 102750 |
| Gender equality champion peer workshop( 1 day, 30 persons, for 2 seasons) | 200 | 30 | 60 | 47 | **137** | 27400 |
| Farming as a business training and mentoring for women groups, 3 days per season, 2 seasons | 750 | 30 | 60 | 47 | **137** | 102750 |

| | | | | | | |
|---|---|---|---|---|---|---|
| Participatory market analysis focused on climate smart value chains with particular relevance for women, 1 day per season | 200 | 30 | 60 | 47 | **137** | 27400 |
| Meet the market and financial institution visits for women farmer groups | 500 | 30 | 60 | 47 | **137** | 68500 |
| Annual peer meeting for women farmer groups - 2 seasons | 500 | 30 | 60 | 47 | **137** | 68500 |
| **Total** | | | | | | **549375** |
| **Total inclusive of 8% sub contracting fee** | | | | | | **593325** |

Through the below training costs example, a total number of 4110 women farmers would be targeted, along with a total of 4110 male and female gender equality champions.

It is expected that capacity building of AGRITEX will strengthen the extension services workers in advocating for gender equality, gender equal participation and decision making in farming, equality in ownership of land and that extension officers tailor extension services to routines and needs of both men and women.

## 6.4 Facilitation of market linkages to sustain smallholders' agricultural adaptation to climate hazards

Increased water security and efficiency through climate resilient irrigation and CRA will significantly increase agricultural production. Climate smart crops and livestock practices will secure smallholders' investments as production becomes more resilient to climate shocks. As production increases and new products and varieties are introduced, **a market linkage component through which farmers can forge links with key market actors for them sell their produce is recommended, as a crucial aspect of transitioning to and sustaining climate smart agricultural production.** The value chain sub assessment analysis was based on stakeholder consultation across value chains[369], an analysis of markets, gender dynamics, as well as climate risks.. It identified several crops within the horticulture value chain, sesame, small grains and sorghum, as well as livestock production, as high potential value chains based on criteria such as high value per hectare, existing production skills, low perishability, well defined formal and informal markets and unmet market demand (see Table X, above, for a summary of criteria). Recommendations to facilitating market linkages between smallholders and market actors are as follows:

1. *Develop market linkages for the identified, high-value, climate resilient crops, through the establishment of 9 multi-stakeholder Innovation Platforms*

Effective and widespread **adoption of CRA practices is significantly increased if there is a ready market for farmers to sell their produce.** This is premised on a production and market analysis that identifies climate vulnerabilities and risks within the value chain in question. The proposed Innovation Platforms should function as a space for **adaptive management of farming practices and facilitating linkages between farmers and market actors across value chains.** The Innovation Platforms allow for continual development of solutions for climate resilient production, adjustments if needed, and engagement across value chains to support the links between producers, buyers and other relevant actors. It is recommended that the project establish 8 Innovation Platforms based on crop-livestock combinations identified in the value chain analysis (horticulture, sesame, small grains and sorghum and livestock), as well as one national level platform to up- and out-scale interventions. The indicative purpose and focus of the Innovation Platforms per value chain, as well as stakeholders identified as active in the market, with expressed or potential interest in being part of a climate resilient approach to market linkages and value chain development, are detailed in Table 21 below.

The proposed project should make use of Innovation Platforms to:

- Manage the roll out of new and innovative, as well as tried and tested, climate resilient agriculture approaches and new crops at the level of each district – informed by experience from ward level Farmer Field Schools
- Identify challenges and develop solutions to link smallholders into value chains
- Conduct a climate and vulnerability risk analysis of the value chain, engaging the multi-stakeholders that comprise the Innovation Platform, to identify solutions to production and marketing challenges
- Facilitate and promote investments into value addition for climate smart crops and livestock production
- Use experiences from the district level to inform decision-making and scale out the approaches across the southern provinces, and feed into decision-making and policy development at national level.

Table 21: Innovation Platforms: focus and actors

| Type of platform | Key stakeholders | Focus |
|---|---|---|
| National and provincial level<br>Upscaling platform | **Key stakeholders**<br>AGRITEX<br>DR&SS<br>Provincial and district level stakeholders reps<br>Private sector reps<br>Financial sector reps<br>National level decision makers<br>Farmers associations reps<br>Micro-finance institutions | **Focus**: Integration of experiences and innovations on development of climate resilient value chains in national level policies<br><br>**Links:** Link to district level platforms. |

[369] The Value Chain Sub-assessment consultation process involved 291 persons as part of the value chain analysis, spread across irrigation scheme plot holders, dryland farmers, commercial producers, input suppliers, informal and formal market actors and buyers, government agencies, industry associations, development programs and researchers.

<table>
<tr><td rowspan="2">Horticulture platform</td><td>Key stakeholders<br>External co-facilitator<br>AGRITEX and Department of Livestock at district and provincial level<br>AGRITEX colleges<br>DR&SS research stations<br>Farmers associations reps<br>Academia<br>NGOs<br>RDC, DA and other local decision makers<br>Private sector players across the value chain<br>Micro-finance institutions</td><td>Focus: To identify problems/challenges and find solutions to how best to climate proof horticultural value chains and markets and at the same time integrate small holder farmers in horticultural value chains.<br><br>Links: Link to FFS at ward level, other innovation platforms across districts, national level upscaling-outscaling platform.</td></tr>
<tr><td colspan="2">Key companies in the horticulture industry include companies which buy a range of horticultural products, such as Best Fruit Processors, specialised horticulture buyers such as African Distributors for spices and seed companies such as Seed Co for seeds. Also, there are formal aggregators and produce markets, where small holder farmers may sell larger quantities of produce.<br>Main aggregators and produce markets are as follows: Manicaland: Brand fresh, Manica Produce; Masvingo: Masvingo Food Commodity Cooperation; Matabeleland South: Bulawayo Produce Market.</td></tr>
<tr><td rowspan="2">Sesame platform</td><td>Key stakeholders<br>External co-facilitator<br>AGRITEX and Department of Livestock at district and provincial level<br>AGRITEX colleges<br>DR&SS research stations<br>Farmers associations reps<br>Private sector players across the value chain<br>Academia<br>NGOs<br>RDC, DA and other local decision makers<br>Micro-finance institutions</td><td>Focus: As it is an emerging value chain for small holder farmers, research institutions will be engaged to support optimization of production for dryland small holder farmers. The focus of the platform should be to identify challenges and find solutions in developing and climate proofing the sesame value chain. At the same time models for engaging and integrating small holder farmers in the sesame value chain will be developed.<br><br>Links: Link to FFS at ward level, other innovation platforms across districts, national level upscaling-outscaling platform.</td></tr>
<tr><td colspan="2">Key market players include Sidella or IETC. Local confectionary industry and bakeries.</td></tr>
<tr><td rowspan="2">Integrated small grains and livestock</td><td>Key stakeholders<br>External co-facilitator<br>AGRITEX and Department of Livestock at district and provincial level<br>AGRITEX colleges<br>DR&SS research stations<br>Farmers associations / groups reps<br>Private sector players across the value chain<br>Academia<br>NGOs<br>RDC, DA and other local decision makers<br>Micro-finance institutions</td><td>Focus: The small grains and livestock platform may focus on small grains for food and nutrition security and commercial production of small grains – as well as crop-livestock integration with goats and cattle, with a focus on commercial production of livestock. The Innovation platform will address challenges in promoting and marketing climate smart small grains as well as issues around building climate resilience in the livestock value chain and improving marketing of livestock. Sustainable management of grasslands will be central.<br><br>Links: Link to FFS at ward level, other innovation platforms across districts, national level upscaling-out-scaling platform.</td></tr>
<tr><td colspan="2">Key market players for small grains: Grain Marketing Board and other millers for all small grains. Delta for sorghum. K2 for seeds. Health foods actors with a focus on small grains. Animal feed producers<br>Key market players for livestock:<br>Manicaland: Small scale buyers e.g. food outlets, Montana castle, MOLU, Export markets, Local markets, festive seasons<br>Masvingo: Small scale buyers e.g. food outlets, Montana castle, Export markets<br>Matabeleland South: Small scale buyers e.g. food outlets, Montana castle, Export markets, Cycle Y (Mbokdo), Head and Hooves, abattoirs</td></tr>
</table>

The proposed strategic institutional levels and key stakeholders for each Innovation Platform to facilitate scaling up and out are illustrated in Table 22 below. The proposed geographical locations are included in annex 25. The phasing of interventions shows an expectation that Innovation Platforms will be phased over to private subscriptions as a form of membership.

Innovation Platforms may also serve as a space for analysing financial challenges from the perspective of brokering connections to formal financial institutions, where possible, as well as looking to increase the appropriateness of financial services offered. Facilitating links to micro-finance and risk insurance institutions allows farmers to access capital to buy agro-inputs to grow a better harvest, and insurance against extreme weather events if yields are destroyed. While access to finance is a crucial component of climate resilience building, this study concludes that the necessary incentives and conditions needed in the financial system and smallholders' capacity to begin to provide smallholders with access to finance would not be in place during the lifecycle of this project. A first step of an approach would likely necessitate group, rather than individual, loan arrangements, as it is considered more attractive in the eyes of formal financial service providers if risk is spread across a group of farmers, than to take out multiple loans with individual farmers.

Table 22: Phasing of Innovation Platforms

| **Type of platform** | **Phasing of interventions** | | | | | | |
|---|---|---|---|---|---|---|---|
| | **Y1** | **Y2** | **Y3** | **Y4** | **Y5** | **Y6** | **Y7** |
| Horticulture Innovation Platform | | Full funding | Full funding | Full funding | Phase out | Phase out | |
| Sesame Innovation Platform | | Full funding | Full funding | Full funding | Phase out | Phase out | |
| Small Grains and Livestock platform | | Full funding | Full funding | Phase out | | | |
| National level upscaling and outscaling platform | | | Full funding | Full funding | Full funding | Phase out | Phase out |

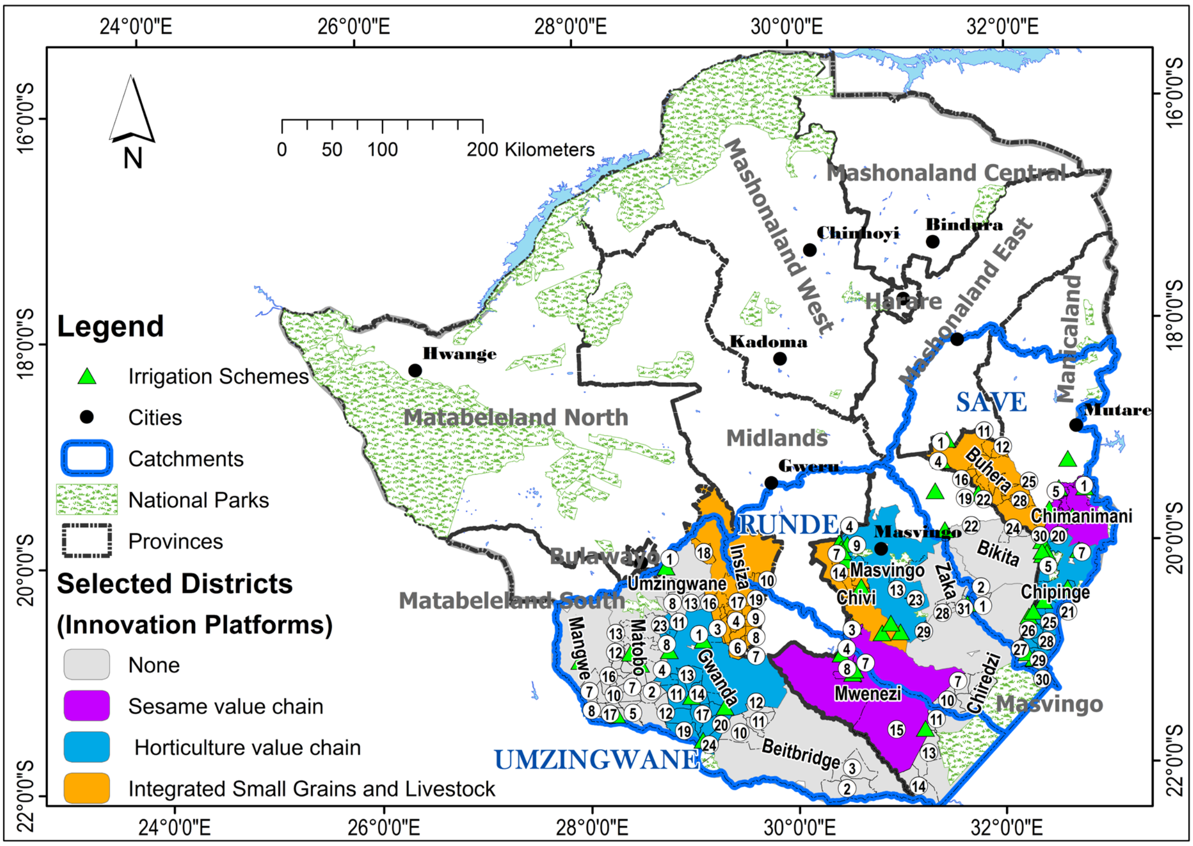


Figure 33: Proposed location of innovation platforms

2. *Link smallholders' climate resilient crop-livestock production to markets*

The private sector plays a crucial role across value chains, as a provider of inputs and technical support to production, and as a buyer of produce. As evidenced from other project experiences and documented in the Value Chain and CRA Package Sub-assessments, impacts are most likely to be sustained through an approach that works with or is driven by the private sector. Leveraging investment from private companies supports efforts to overcome barriers faced by smallholders in climate resilient crop production, particularly in value addition, transport and providing inputs and technical assistance. As identified by the Value Chain Sub-assessment and reinforced by the CRA package stakeholder consultations, linking smallholders to private companies in out-grower schemes and contract farming arrangements is a way of integrating smallholders into markets to sell their crops and build confidence between smallholder producer groups and companies. Successful efforts and best practice in the horticulture sector should be built on. In doing so, there needs to be a particular focus on involving women smallholders and increasing the role of women as entrepreneurs, to contribute towards gender equal opportunities.

Key recommendations on encouraging private sector investment in linking smallholders to markets, primarily through contract farming are:

- The multi-stakeholder Innovation Platforms should effective communication and collaboration to facilitate Public-private partnerships between actors in overcoming bottlenecks and obstacles in the value chain to market expansion.
- The Value Chain Sub-assessment pointed to the potentials for value addition throughout the value chains. Value addition initiatives should be carried out in a mix of public, private and public-private investments, facilitated through the Innovation Platforms. In particular, the project should look to build on existing value chain support e.g. the Scaling Up Adaptation project interventions and agreements with agri-businesses and smallholders.
- At the level of smallholder farmers, the project should provide basic value chain investments, making the selected value chains more attractive for farmers and increasing income generation. The CRA Package Sub-assessment recommends investments into basic post-harvest handling such as storage

facilities for horticulture produce, small scale storage and labour-saving processing equipment for small grains as well as marketing facilities for cattle. These basic investments will enable smallholders to access the markets with products of improved quality and gain more income.

- For larger commercial investments into processing and more sophisticated value addition, the private sector should be encouraged to invest in large cooling facilities for horticulture produce and meat as well as processing plants for horticulture produce if the production and the market is there. Vice versa, government actors may be encouraged to work towards creating a more enabling environment for new enterprises to become established and investments to be made, if this is identified as a need.
- Consultations revealed that facilitation of direct farmer-meets-the-market visits had been useful for farmer groups, as had Innovation Platforms with a focus on joint value chain development and building of stakeholder relationships. These initiatives have helped build a better understanding between smallholders and the commercial buyers in terms of the mutual expectations, e.g. in contract farming, provision of the right inputs at local level and improved dialogue, and should be used as an implementation approach in value chain development.
- While contract farming arrangements, particularly in the horticulture sector, offer the greatest potential to lift smallholders out of poverty, it is recommended to take a two-pronged approach to link smallholders to market: i) focus on facilitating smallholder entry into the formal market (e.g. through fair and effective out-grower and contract farming arrangements, mainly for sesame and horticulture and effective marketing arrangements for livestock), and ii) support entry into the informal municipal markets (which have lower barriers to entry for smallholders into markets, mainly for small grains).
- During consultations, a need for farmers' associations to coordinate and work together was identified. Many smallholder farmers are used to working independently on their own plots and not necessarily pool resources, work together or organize themselves in a commodity association to bargain collectively and produce and sell at scale. The project may therefore also consider to facilitate support to farmers groups to articulate a common vision, to work through commodity/farmers associations to increase negotiating power and pool resources when engaging with private companies.

Innovation Platforms will play a role in sourcing in public and private finance to support value addition and climate resilient value chain development. The project should coordinate with other investments, namely ZRBF projected investments, on value addition and value chain development in the most vulnerable districts as part of their consortium investments. The Value Chain Sub assessment identified both small scale, farmer level value addition options as well as potentials for large scale public-private investments. It is recommended to support basic value addition investments, as these are low hanging fruits that may open up for other private sector investments. In addition, options for PPP investments in value addition may be further explored as part of Innovation Platforms for climate resilient value chain development.

*3. Support AGRITEX capacity building on 'farming as a business'*

The majority of stakeholders agreed that **a commercial take on smallholder farming** is key to building more secure and profitable livelihoods and successful adoption of CRA practices for crops and livestock. The CRA package consultations identified a need to include elements of capacity building of 'farming as a business' for AGRITEX Extension Officers, smallholder groups and individual farmers, in order to facilitate fair and effective links between smallholders and value chain stakeholders – and to sensitise private sector players on how best to deal with smallholder farmers.

Lastly, the capacity building of both smallholder farmers and AGRITEX officers is closely linked to the sustained functioning of irrigation schemes, as it will be key to address issues of 'farming as a business', promotion of a coordinated approach among farmers to linking up with markets and accumulation of sufficient revenue to cover operation and maintenance costs.

At the level of the FFS, the CRA package should include:

- Training in business management skills and facilitation of communication with the private sector on input, technical assistance, buyers' demands for crop quality standards and potentials for entering into contract farming relationships.

At the level of the Innovation Platform, the CRA package should include:

- Participatory analysis of climate resilient value chain development with a wide range of stakeholders, incl. private sector and small holder farmers

- Capacity building of farmers associations / commodity associations based on needs assessment through Innovation Platforms

In terms of capacity building of AGRITEX officers, it will be key to:

- Build capacities of AGRITEX officers both through training in business management skills and facilitation of market linkages for small holder farmers as well as through a learning by doing approach through participation in Innovation Platform value chain discussions and stakeholder engagement.

It is recommended that capacity building efforts within AGRITEX are rolled out through training of a group of national and provincial level master trainers within DR&SS and AGRITEX, who may then cascade trainings to district and ward level AGRITEX Extension Officers, AGRITEX teachers and students as well as develop training materials and guides for CRA.

As described above, Innovation Platforms, market linkage platforms, market price data bases and similar initiatives have been useful and effective to improve links between value chain stakeholders. The CRA Package Sub-assessment also identified a need to **facilitate provision of market information.** Rather than construct new services, the most relevant and cost-effective existing services should be sought out and promoted. The approach should consider how these sources can best complement and synergize with the agro-met information services being scaled up as part of this project, as well as make use of Innovation Platforms as a form of distribution.

#### *6.4.1.1 Costing of facilitation of market linkages to sustain smallholders' agricultural adaptation to climate hazards*

The tables below detail the overall costing for Innovation Platforms throughout the project period

| **Cost category** | **Cost per unit** |
|---|---|
| Horticulture IP: 3 years | 279514.8 |
| Sesame IP: 3 years | 279514.8 |
| Small grains and livestock IP: 3 years | 279514.8 |
| Upscaling platform | 63072 |

| **Cost category** | | **Year 1** | **Year 2** | **Year 3** | **Year 4 (50%)** | **Total** |
|---|---|---|---|---|---|---|
| **Human resources for facilitation** | Percentage of time | | Cost per year | Cost per year | Cost per year | |
| Innovation platform facilitator | Monthly fee per platform meeting | 12000 | 12000 | 12000 | 6000 | |
| Assistant to coordinator of innovation process | 50% | 18000 | 18000 | 18000 | 9000 | |
| External thematic support | Estimated at 500 USD/month | 6000 | 6000 | 6000 | 3000 | |
| **Total HR for facilitation costs** | | 36000 | 36000 | 36000 | 18000 | **126000** |
| **Basic event costs** | | | | | | |
| Meeting costs | 4 meetings a year, 30 persons, incl. DSA per person and transport | 9000 | 9000 | 9000 | 9000 | |
| DSA for external experts | 5 persons at 225 USD each, 4 times a year | 3000 | 3000 | 3000 | 3000 | |
| Transport for external experts | @ 20 cents per km | 480 | 480 | 480 | 480 | |
| Venue hire - DR&SS facilities | 100 USD / day @ 6 days per year | 400 | 400 | 400 | 400 | |
| Office supplies and other materials | 3/ USD / person / meeting | 360 | 360 | 360 | 360 | |

| | | | | | | |
|---|---|---|---|---|---|---|
| Inception meeting - 3 days | 3 days, 30 persons incl. DSA per person and transport | 4950 | 4950 | 4950 | 4950 | |
| **Total basic event costs** | | | | | | **67810** |
| **Total costs per innovation platform** | | | | | | **193810** |
| **Platform demonstration costs** | | | | | | |
| Estimated cost per platform for demo plot facilities for host institution | 5000 USD | | | | | 5000 |
| Production, layout, printing, dissemination of CRA related learning materials | Per platform | | | | | 30000 |
| Demonstration of climate smart value addition and marketing facilities | Per institution | | | | | 30000 |
| Total demonstration costs per platform | | | | | | **65000** |
| **Total costs per innovation platform incl. demonstration facilities** | | | | | | **258810** |
| **Total cost with 8% administration fee for executing institution** | | | | | | **279514.8** |

The CRA package study identified possible, basic value addition and market investments to promote climate resilient agriculture practices, crops and livestock. Unit prices are given below as is a proposed number and type of investments. While it would be ideal to invest in climate smart small grains and livestock value addition and marketing facilities across all wards, the estimate below is based on the number of wards targeted per crop-livestock combination through Farmer Field Schools and takes into account a spreading of investments across wards dependent on a needs assessment and potential investments already made by other projects across the wards.

The proposed investments into value adding infrastructure to support uptake of climate resilient agriculture practices and marketing of products are low cost and low maintenance, with small holder farmers being requested to take up maintenance tasks at no or minimal costs and make in-kind investments in terms of labour for setup and upkeep of structures.

| **Type of value addition investment** | **Unit cost in USD** |
|---|---|
| Assessment of optimal threshing, dehulling, milling and storage demonstration facilities for small grains | 15000 |
| Threshing, dehulling, milling and storage demonstration facilities for small grains - per target ward | 17500 |
| Marketing and sustainable production demonstration facilities for livestock – per target ward | 25000 |
| Storage facilities for horticulture per irrigation scheme | 5000 |
| Storage facilities for sesame per ward, provided by private sector | 0 |
| **Total cost** | |

#### *6.4.1.2 Unit costs for AGRITEX capacity building on CRA*

The table below summarises the unit costs for capacity building for AGRITEX throughout the full project period, consisting of training courses on technical elements of CRA and market linkages, including farming as a business training, and refresher trainings where experience and best practice is reflected upon to be applied to the next season. Cost calculations are based on Scaling Up Adaptation costing and costing from ZRBF's MELANA consortium.

Indicative costs for AGRITEX capacity building for CRA and farming as a business are shown below:

| **Capacity building for AGRITEX throughout full project period** | **Phasing of trainings over project years** |
|---|---|

| Activity | Cost description | Unit cost in USD | Total no. | Total cost in USD | Y1 | Y2 | Y3 | Y4 | Y5 | Y6 | Y8 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Training of DR&SS and AGRITEX staff in facilitation of IP's | Training cost per person, incl. travel | 8500 | 9 | 76500 | | | | | | | |
| Training of Trainers of DR&SS and AGRITEX at national and provincial level (incl. agricultural colleges and DR/SS research station staff) on specific CRA related topics, including on 'farming as a business'. | Cost per 3 day training of 30 persons. All inclusive, with travel costs, venue costs, training institution fee | 17625 | 5 | 88125 | | | | | | | |
| Annual review meetings for DR&SS and AGRITEX trainers at national and provincial level, on lessons learned and best practice on IPs and CRA implementation | Cost per 2 day meeting of 30 persons. All inclusive, with travel costs, venue costs | 8175 | 5 | 40875 | | | | | | | |
| Training of ward, district and provincial level staff (by trained trainers, from capacity building, above) on specific CRA related topics (Total number of persons to be trained: at least 137 ward level, 15 district level, 3 provincial level AGRITEX staff) | Cost per 3 day training of 30 persons. All inclusive, with travel costs, venue costs, training institution fee, in-house resource person | 15900 | 30 | 477000 | | | | | | | |
| Training of ward, district and provincial level staff (by trained trainers, from capacity building, above) on topics related to farming as a business. (Total number of persons to be trained: at least 137 ward level, 15 district level, 3 provincial level AGRITEX staff) | Cost per 3 day training of 30 persons. All inclusive, with travel costs, venue costs, training institution fee, in-house resource person | 15900 | 30 | 477000 | | | | | | | |
| District - ward level reviews/ refresher trainings on CRA best practice and innovations to build on experience for next season (Total number of persons to be trained: 137 ward level, 15 district level, 3 provincial level AGRITEX staff) | Cost per 2 day review/follow up training of 30 persons. All inclusive, with travel costs, venue costs, training institution fee, inhouse resource person | 6550 | 25 | 163750 | | | | | | | |
| **Total cost** | | | | **1323250** | | | | | | | |

## 6.5 Climate information and early warning for water and agricultural management

Smallholder farmers are vulnerable to periodic and long-term changes in climate and weather-related extremes, in part because they have little or no access to localized weather and climate information and no systems or ways of using this information to manage climate risks within their agricultural livelihoods. Access to localized weather information will help the situation given that the intensity and spatial differences in weather types varies between areas even in the same AER. Besides the issue of 'accuracy' related to weather and climate information, it is clear that improving this accuracy is not sufficient for its use to manage climate risks. Weather/climate information needs translating into a format and variables that directly relate to the users of the information and the decision they make. Within this project, dryland farmers need information such as when to plant (season onset), which cultivar to plant (length of rainfall season) and when to apply inputs such as fertiliser on a short-term basis (if there is enough rainfall). Irrigation farmers and IMCs furthermore require weather/climate information to decide on irrigation scheduling for different crops, as well as how much water will be available, which is decided by ZINWA based on hydrological projections of dam yields. Additionally, getting the information to those who need it becomes difficult when smallholder farmers, extension officers and IMCs are geographically spread with limited access to media, as well as limited capacity to understand the content and reliability of the information (even assuming it is given in a language they understand). Given this situation and the focus of the project on irrigation schemes and dryland farming, this study recommends interventions to focus on four aspects related to weather/climate information, based on previous analyses of current human and technical capacities, gaps in delivery of existing investments, their best practice and lessons learned, and identified barriers:

1. Expanding coverage of meteorological and hydrological observation infrastructure;
2. Capacity-building of hydro-met staff on operations & maintenance (O&M), data collection, modelling and forecasting;
3. Support capacity building of service providers to enable the generation and translation of timely forecasts, including training in new technologies and the ability to interpret forecasts and data as applicable to agricultural climate risk management;
4. Develop and scale-up water resource modelling and flood risk information as operational tools utilising hydromet observations, weather and seasonal forecasts;

Each of these activities are detailed further below. It is recommended to coordinate closely with other actors supporting enhanced climate information systems and services, namely WFP.

#### *6.5.1.1 Expanding coverage of meteorological and hydrological observation infrastructure;*

This study recommends installing **new automatic weather, voluntary rainfall and hydrological gauging stations** to address the current low density of observations in southern Zimbabwe. The exact type of station and associated sensors depends on the purpose for which the station is intended.

There are currently 20 meteorological stations in the 3 catchments (see annex 9) all of which (except the 3 AWS at DR&SS research stations) report to MSD, though irregularly and often with a time delay of 10 days to 1 month (except the AWS and synoptic stations). Annex 24 provides maps and tables showing where extra meteorological stations are recommended to be placed, based on existing gaps in the meteorological network. It is recommended that altogether 21 AWS are installed, though the exact location depends on availability of observers and government land in these areas. Additionally some of these stations should be placed at existing synoptic/climate station sites, which will allow both error checking, redundancy should the AWS fail and the development of a continuous timeseries of data into the future (overlapping periods will allow the older timeseries from the manual sensors to be merged with those reading taken by the AWS). It is further recommended that low-cost AWS be installed at a mixture of existing climate/rainfall measuring sites (again monitoring the same site as the manual readings for the same reasons as for the synoptic/climate sites) and new sites needed to cover gaps in the existing network e.g. Chivi, Mwenezi, Insiza and Beitbridge rural districts. These low-cost AWS will provide adequate observations at a fraction of the costs of the full AWS and with lower O&M costs overall. The exact mix of low-cost stations at existing vs new sites needs to be developed in consultation with MSD/ZinWA and local communities where they will be installed, but a total of 20 low-cost stations is envisaged to be sufficient to cover remaining gaps in the geographical coverage. A good example of this would be to use TAHMO stations as a low cost alternative, where the stations are covered in terms of siting and O&M costs for 3 years.

Installing new stations is often considered more cost effective than repairing and retrofitting obsolete weather monitoring equipment, though this needs to assessed on a case by case basis. Where manual stations are being replaced by AWS this makes sense, but if there already exists an AWS which is relatively new, then it is preferable to replace only failed equipment, rather than a whole new AWS. The siting of equipment is important for safety and power etc. and public-private sector partnerships (PPP) may be important to consider, drawing from successful previous experience of relying on private voluntary rainfall stations. PPPs can be considered both in terms of siting requirements and where possible sharing the costs of equipment and/or data transmission charges.

Hydrological monitoring systems similarly require investment, in particular to: (i) rehabilitate gauging stations as far as possible and identify new sites required for calibrating and informing the development of water resource models; (ii) develop a water resource forecasting model, supported by the requisite training; and (iii) support regional monitoring efforts in SADC through sharing hydrological data across shared water courses in the targeted river basins. Annex 25 provides maps and tables where new hydrological stations are required, based on existing gaps in the hydrological network and the need for monitoring of mid-catchments and inflows into dams and water holding areas. A total of 10 sites are identified through discussions with ZinWA, though as with the meteorological stations the exact locations will be determined based on the need to supplement existing manual stations (which also have existing concrete structures, reducing construction costs), availability of government land and observers.

Besides investment in observational infrastructure, it is recommended that consolidation of the telemetry systems to collect data form both the AWS and hydrological gauging network is undertaken. MSD should upgrade to the latest version of Climsoft (version 4), and ensure that all telemetry systems, whether cloud based, from vendor specific systems or private companies, report in real time to a single database which is used as the collection and QA/QC point. Similarly ZinWA should undertake a similar exercise to ensure the HYDSTRA database automatically receives the measured daily updates. In addition to collecting the data both organisations need to share the collected data with each other (the AWS data will be needed for the water resource modelling at ZinWA) and provide a system which allows other users e.g. AGRITEX, CPU and NEWU to access the data in real time i.e the same day.

The digitizing of existing weather and hydrological data for the 3 catchments will need to be supported as well (as these data will support the development of the satellite debiasing procedures and MOS statistical downscaling models). MSD estimate there are 14 stations each with a backlog of 6 years of data (12 variables), which need to be digitised. This is expected to require hiring an additional 20 part-time staff (for 5 months) to undertake the imaging, quality control work and database entry. Alternatively, the use of software with text recognition can be considered for this work, depending on the range of formats the data is to be found in.

#### *6.5.1.2 Capacity-building of hydro-met staff on operations & maintenance (O&M), data collection, modelling and forecasting;*

Beyond the infrastructure, it is recommended that the capacities of hydro-met and agricultural extension staff are strengthened in data analysis, modelling, processing and generation (often rapidly) of information for forecasting. Most equipment is obsolete and software outdated. Retraining will be required where new hardware and software is installed. The MSD is using the ZHPC, located at the UoZ, and is already using over 50 per cent of its capacity in running regional climate models (RCM) over Zimbabwe. There have been problems with bandwidth and associated costs (though technical problems have recently been resolved) and provision needs to be made to cover some of these costs, at least during the early part of the project until sufficient GoZ budgetary support can be provided). For MSD to be able to run finer resolution models over southern Zimbabwe and to enable the generation of localised climate information at sub-district level, MSD’s computing power will need to be increased through the provision of 3 high end PCs equipped with appropriate disk storage capacities and uninterruptible power supplies (UPS). However, it is recommended that the priority should be on properly utilising existing models and assessing their skill before moving to run them at finer resolution; the costs in terms of time and money are not justified if the models do not indicate sufficient increases in forecast skill. In this regard efforts should be made to introduce the use of Model Output Statistics (MOS) as a simpler way of generating quantitative forecasts for locations with long timeseries of observations – using statistical techniques this can be achieved quicker and at less computational cost than relying on an RCM (these procedures can be run on a desktop PC). Both forms of downscaling should be pursued and complement each other. Seasonal forecasts can also be improved based on experiences in the UNDP coping with drought project. The implementation of more user-friendly forecasts based on simple decision tree approaches and monitored atmospheric indices should be further used and investigated by MSD, as well as their application beyond Chiredzi which was the trial site. Staff at MSD therefore need training to run NWP models and improved seasonal forecasting techniques, including application of MOS to internationally available weather and seasonal forecasts.

ZINWA also needs similar capacity support in training once new hydrological monitoring hardware and software is installed. Training staff across departments at the same time is the best approach to ensure shared understanding, effective collaboration and partnerships for climate and weather information systems. In particular, ZinWA staff need training in the use of water resource models, including the development and operationalisation/use of the Pitman/WEAP model for regular/operational water management. This development will need to ensure that the model system incorporates daily updates of hydromet observations and forecasts (from both MSD and ZinWA) and ensure access to MSD daily observations, downscaled weather (both MOS and RCM-based) and seasonal forecasts. This will require processes, standard operating procedures and allocation of staff to be developed between and at ZinWA and MSD, and applied to ensure regular operational updates.

Further training of MSD staff is needed to combine the weather station data (both from manual and AWS stations) with other data sources, including satellite-based observations and forecast data. Part of this training/development should ensure that weather and seasonal forecasts are operationally (daily and seasonally) translated into data formats that can be used by ZinWA for water resource modelling and AGRITEX for translation into agricultural advisories. To do this MSD staff or a subcontracted private company/international organisation (e.g. using ENACTS software developed by IRI at Columbia University) need to develop the required software code and procedures. Satellite data (TRMM, GPM and Meteosat) should be combined with all existing weather station data to produce a debiased satellite rainfall product. The debiasing procedure will be operationalized (debiasing satellite estimates on a daily basis) to improve the accuracy of satellite based estimates of rainfall, creating a merged product to be used as the basis for weather alerts and forecasts in areas not covered by Met stations.

Technicians at MSD and ZinWA will need to be trained on O&M procedures for the installed AWS and hydrological water level stations and associated telemetry systems. This will need to include training on calibration of sensors, as well as developing an O&M business plan, so that repair and telemetry costs are planned and are considered when preparing annual budgets.

#### *6.5.1.3 Support capacity building of service providers to enable the generation and translation of timely forecasts, including training in new technologies and the ability to interpret forecasts and data as applicable to agricultural climate risk management.*

To maximise the potential use of the data generated in 1 & 2 information products need to be produced which ensure timely and detailed weather, climate, hydrological, and crop-related forecasts are available to support smallholder farmers in agricultural planning, as well as supporting risk insurance provision by service providers.

*Generation and translation of new forecast products*

Some of these activities would, in the past, have been part of the NEWU. However, restarting the NEWU and all its functions (e.g. vulnerability assessments) goes beyond the scope of this project. It is therefore recommended that the activities that directly support the objectives of this project are supported through GCF, recognising that these functions can, at a later date, support the reinstatement of the NEWU if funding for its additional functions materialises. In particular it is recommended that NEWU's function to coordinate, collect and synthesise climate data should be supported, since it works across many government departments and NGOs. The capacity to incorporate weather/hydrological observations and forecasts into food security projections requires coordinating and analyses from MSD, ZinWA and AGRITEX. To do this, it will be necessary to support the establishment of a comprehensive information management system that facilitates concerted action in processing, providing and packaging information for sustaining water supply and its efficient use, as well as climate resilient crop production. Such a system will need to incorporate local indigenous knowledge where possible, including information on current conditions; enable participation and decision-making of women; and be informed by both external weather and climate risks, as well as corresponding internal household or individual climate vulnerability indicators.

A further requirement is the design and delivery of tailored weather/climate and agricultural advisories (for range of media including radio, TV and print) given available data and co-exploration feedback from farmers and communities. This will need to involve operationalising the production of tailored products, including developing software/code and procedures. This necessitates capacity building of technical and professional personnel to interpret and process information for appropriate and **tailored packaging** for the indicated audience: smallholder farmers and their associated institutions. It also requires the development of appropriate and **functional products** to present the information. How government departments, particularly the NEWU, communicate messaging needs to be re-evaluated from the perspective of considering the most appropriate user-interfaces for the climate information, or 'climate user interface platforms', for the purpose and type of knowledge and the needs of the intended audience. AGRITEX's presence at the local level is an important asset, which should be utilised. Other forms of local leadership, such as traditional leaders, will also form part of the dissemination strategy. It is important that there are possible synergies between the various strategies.

*Information dissemination and feedback*

Lessons from the UNDP/GEF OXFAM and Practical Action pilot of Climate User Information Platforms (CUIPs) should be built on to inform the design of communication modalities. It is recommended that this is done by building on and scaling up the efforts under the UNDP/GEF supported project Scaling up Climate Change Adaptation in Zimbabwe. Moreover, appropriate indigenous knowledge should be recorded, validated and incorporated into formal information products, as not only is this important information which could enhance the system, but it promotes an inclusive, localised and tailored approach to collection and communication of information. ICT platforms and digital data platforms should be scaled up to complement the transmission of information through other media. This will require designing and delivering weather/climate and agricultural information packages for assimilation into the FrontlineSMS services being developed through the Oxfam

UNDP/GEF project. It will be necessary to engage with Econet, NetOne and Telecell on distribution services and ways to reduce costs e.g. bulk SMS, as well as operationalising the production of tailored products: software and procedures. It is recommended that two FrontlineSMS systems be set up, one at MSD for distributing weather advisories, and one at AGRITEX for distributing agricultural advisories (which take into account the feedback from AGRITEX extension workers at different localities). Having two systems recognises several barriers to the use of information: a) the intended users of weather and agricultural advisories will be different; b) AGRITEX needs to include other information from each target location when developing the advisory; c) two systems will give both MSD and AGRITEX a sense of ownership in the process when sharing information.

*Developing capacity to understand and interpret information products*

District and ward level training is recommended mainly for AGRITEX staff – supervisors, technical specialists and extension staff. Such training should focus on interpretation of weather and climate information products, use of information, and how best to disseminate it. Smallholder farmers (in particular lead farmers), the users of the information, need to be trained firstly to appreciate, or understand the implications of, meteorological and hydrological data, as well as to validate their application of the information. The latter should include the development of risk management options in consultation with farmers, so that farmers are prepared to use those options when a forecast is sent e.g. training of trainers (ToT) used in the PICSA approach by University of Reading. The PICSA component should be carried out in coordination or partnership with the recently approved WFP/GCF project targeting Rushinga and Masvingo with PICSA. Additionally, the distribution of plastic rain gauges to farmers and training on interpretation and comparisons with data from nearby weather stations (part of CRA work) should be undertaken as part of the sensitisation to the use of weather/climate information.

The capacity of farmers to be able to access information, understand it and, most importantly, apply it to their farming practices, needs to be developed. Farmer field schools and training days should include capacity building in understanding and applying weather/climate forecasts provided to farmers and IMCs. An important component of this capacity building strategy is to ensure farmers are given multiple opportunities for feedback on the information which is being presented and how it is being disseminated, as well as active participation in its collection, dissemination and communication. The distribution of plastic rain gauges to farmers (noted above), and training on how to interpret and use the collected rainfall information will help understand forecasts and advisories. This will increase farmers' sense of ownership in the process and increase their interaction with the data, thus helping increased chance of engagement and, ultimately, application of the information.

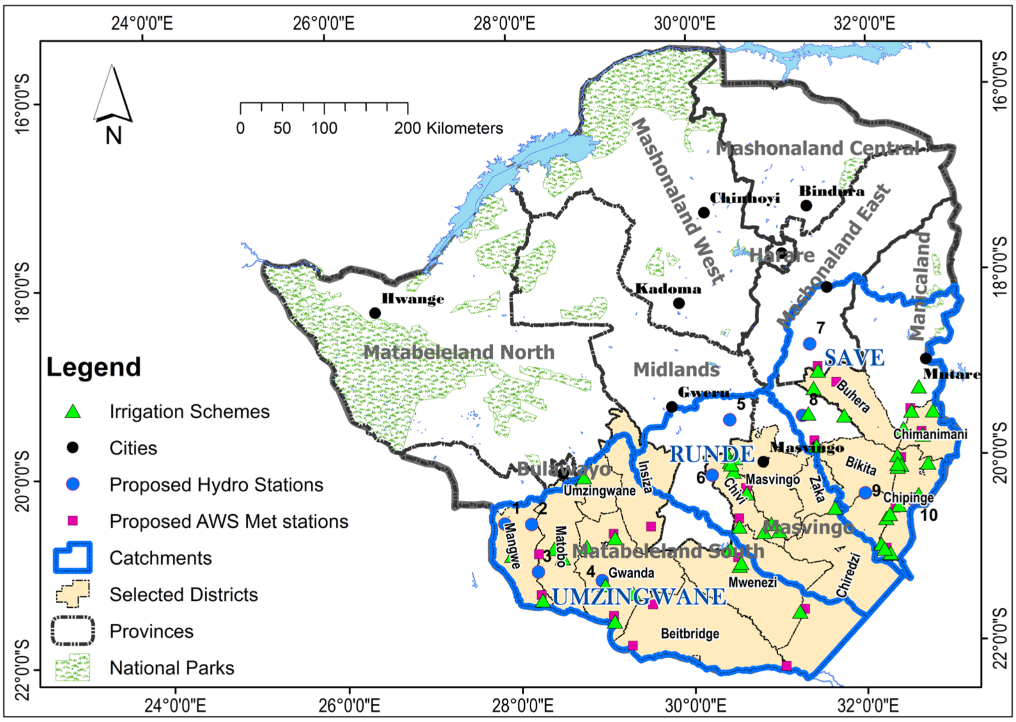
#### *6.5.1.4 Develop and scale-up water resource modelling and flood risk information as operational tools utilising hydromet observations, weather and seasonal forecasts*

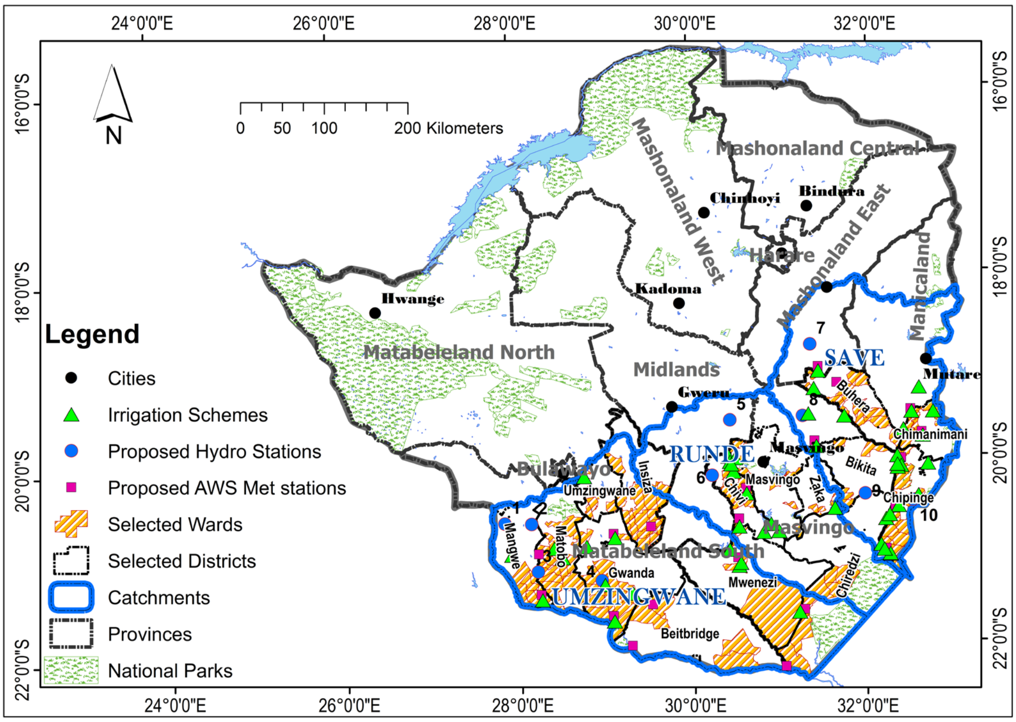
During the scoping of the project it was clear that there is limited capacity at ZinWA to model water resources within the southern catchments, but this capacity could be built utilising the Pitman or WEAP models which are currently available. One of the key information requirements for catchment managers is the expected yield of a dam which is used to make water allocations to farmers and irrigation schemes, a decision usually taken in April/May. Whilst seasonal forecasts may be too uncertain at this time of year to enable planning for the coming season (i.e. issuing water allocations), updates to the seasonal forecast and ongoing weather forecasts during the rainfall season could be used to influence the decision of whether to open sluice gates and other dam management practices i.e. ahead of expected rains. Furthermore, this information needs to be communicated to IMCs who can use it to schedule/plan their use of irrigation. This will require capacity building within the catchments to allow ZinWA catchment officers and IMCs to interpret new products and information on water management (e.g. from the water resource modelling developed in 2 above), including co-production of materials and information products. This will also require the design and delivery of tailored water management and scheduling advisories (in partnership with DoI) based on hydro-met observations and forecasts, given available water, expected crop requirements and co-exploration initiatives with ZinWa and IMCs The software and code to operationalise the production of tailored products will also need to be developed.

As part of this work it is also recommended that DoI revisits the FAO irrigation scheme modules to ensure that changes in climate and water availability in each catchment are considered when designing new schemes. It is also necessary to introduce the flood risk maps developed at UoZ into the design of irrigation schemes to minimise the risks to irrigation infrastructure, including pump placement and location of irrigation infrastructure. This will involve using available hydromet data to improve the flood risk maps where feasible, and developing guidelines on irrigation scheme placement and dryland farming (to avoid areas of high flood risk).

#### 6.5.1.5 Costs for climate information and early warning for water and agricultural management

The maps below show the proposed locations for hydro-met stations to increase coverage of the hydro-met observation network for the Southern part of Zimbabwe.



The overall costing of the proposed actions for the component on climate information systems is shown below. It is based on costs for similar training and equipment quotes, as obtained as part of the climate information systems study[370].

| Proposed actions | Description of costs | Budget Estimates |
|---|---|---|
| Installation of 12 automatic weather stations to cover key agricultural zones and 10 automatic low cost rainfall/weather stations to improve rainfall monitoring in the three catchments | Agromet AWS @ $25,000 each | 300000 |
| | 10 low cost rainfall station (e.g. TAHMO) @ $5,000 each | 50000 |
| | Installation, travel | 50000 |
| Installation of new or rehabilitatation of 10 water level/gauging stations at strategic points in the three catchments | 10 stations mixture of rehabilitation and new stations. | |
| | 6 new stations @ $40,000 each | 240000 |
| | 3 rehabiliated stations @ $15,000 each | 45,000 |
| | 1 rehabilitated station @ $ 25,000 each | 25000 |
| | Installation, travel | 50000 |
| Strengthening of the hydro-meteorological data transmission and processing system to enable localized weather, climate and hydrological model forecast generation | Cost for international consultants and training programmes, incl. software, supporting capacity building in MSD and ZINWA in coordination with WFP | 150,000 |
| Identification and training of MSD, ZinWA, DR&SS/AGRITEX officials, community observers (low-cost stations) in collecting data, operating and maintaining equipment | 1 training each for MSD & ZinWA observers for 2 years @ $37,500 per training, including costs for bringing observers from 3 catchments together. In coordination with WFP | 75,000 |
| Training of staff at ZinWA in the use of water resource models in partnership with UoZ. Operationalisation of regular hydrological forecasts, incorporating daily updates of hydromet observations and forecasts; | 2 trainings in using water resource models (WEAP/Pitman) @ $25,000 each (International consultants). | 50,000 |
| Training of staff at ZinWA in the use of water resource models in partnership with UoZ. Operationalisation of regular hydrological forecasts, incorporating daily updates of hydromet observations and forecasts; | 1 PC server + ICT costs (internet, storage, software) @ $20,000. | 20,000 |
| | International/national consultants to develop and operationalise code and procedures, including data feeds with MSD server to receive real time rainfall observations + data feed from hydrological stations. Operationalise assimilation and forward projections, using weather and seasonal forecasts from MSD. | 265,000 |
| Inter-agency group analysis of information collected regionally and locally, and development of information products that strengthen existing national satellite/observation-based weather, 10-day and seasonal forecasts and advisories; | One interagency group working on agromet advisories for dryland farming (AGRITEX, MSD, WFP and DR&SS). Second interagency group (ZinWA, MSD, DOI) working on water resource and irrigation scheduling advisories for water managers and IMCs. Each group gets $400,000 spread over the lifetime of the project. Costs are for regular meetings monthly in Harare, ICT (1 PC for each institution + analysis software if needed), travel, workshops and product development activities as part of development of advisory products. Supported by UNDP and WFP. | 105,000 |
| Identification and development of appropriate information dissemination channels such as mobile phones, community radio, community meetings and local posters and bulletins; | Costs of SMS messaging (At least 2 messages per month for 6 years) for both FrontlineSMS systems. | 100,000 |
| | Costs of community radio programme engagement and dissemination @ 100,000. | 100,000 |

[370] Cf. Appendices20 and 21

| | | |
|---|---|---|
| | 20 community meetings @ $5,000 each. | 100,000 |
| | Designing and formatting weather and agricultural advisories for SMS and radio communications, translation into local languages etc. | 60,000 |
| Promotion of adoption and use of information through awareness and capacity building of beneficiaries. | | 0 |
| Provision of training to DoI, ZINWA and CMC staff, at national and catchment level, in data analysis, modelling, forecasting and use/production of information products on water allocations and irrigation system design; | Operationalise flood risk maps developed at UoZ. Improve using available hydromet data and use to develop guidelines on irrigation scheme placement and dryland farming (avoiding areas of high flood risk). Capacity building national and within the catchments to allow ZinWA CMCs to interpret new products and information on water management and dam releases, including co-production of materials and information products (one training in each catchment each year for years 2,3,4 of project @ $20,000 per training). Training given by national ZinWA, MSD and DoI staff. | 70,000 |
| | | 180,000 |
| Provision of training to district and local level intermediaries - Agriculture Extension staff, MSD and IMC - in interpretation and dissemination of climate and weather information products for crop/water management and crop irrigation scheduling; | PICSA training in 3 areas by WFP. Spread over 4 years.Coordinated with WFP. Incl. Training for Midlands State University, AGRITEX and others to utilise training to train lead farmers in target areas | 1,500,000 |
| Assessment of market for climate information services (CIS) and engagement with private sector users to develop services and business models for CIS | Market study to establish potential revenue generating services for agricultural, water management and flood advisories/warnings in the three catchments | 40,000 |
| | Engagement and discussions with private sector on developing paid for services and revenue generation ($60,000 - meetings and travel costs for forst 3 years of project @ $20,000 per year). | 60,000 |
| | ZimNAT developing triggers for crops, as well as pricing schemes - $60,000; | 60,000 |
| | International consultants (IRI) to provide satellite debiasing code and procedures and training in coordination with WFP; | 50,000 |
| | ICT, bandwidth, accessing data and operationalising the product - making it available to ZimNAT on a regular basis | 60,000 |
| | Development of satellite and AWS products for monitoring and WII triggers, allowing expansion of WII to areas not covered by AWS (meetings, travel, engagement between ZimNAT and MSD - $30,000 spread over 3 years; | 30,000 |
| Enhancement and development of climate knowledge centres at existing DR&SS, and AGRITEX district offices | Printing and distribution of print materials (advisories, climate education) at DR&SS and Agritex offices | 75,000 |
| | Equipment, transmission and delivery facilities (emails, internet, cellphones for receiving agricultural forecasts) at Agritex offices and DR&SS | 52,500 |
| | Capacity Building of local AGRITEX and DR&SS officers to interpret advisories and materials | 70,000 |
| | Translation of materials into local languages | 10,000 |
| **Total indicative costs** | | **4,097,500** |

## 6.6 Institutional coordination and knowledge management for transformational, system-level changes for support to agricultural livelihoods to adapt to climate change at scale

This study has identified a series of institutional coordination and knowledge management gaps and barriers that are preventing farmers from receiving services and increase their capacities and resources to build climate risk management into their livelihoods. Efficient institutional coordination, both centrally in national-level government ministries and departments, and across levels, provides a clear framework to guide service providers to deliver services to farmers. Institutional coordination is also essential in facilitating system-level changes to enable sustained and transformational climate resilience and adaptation impacts that last beyond the lifetime of interventions. At the core of this approach is collaboration among key stakeholders, including government and non-governmental organizations, research institutions, financial institutions, private companies and entrepreneurs, smallholder farmers, input suppliers and product buyers.

This study recommends that a **national level coordination mechanism** should be supported, comprised of the primary institutions relevant to climate adaptation of agricultural livelihoods in southern Zimbabwe. In addition, the network of **multi-stakeholder Innovation Platforms at district level**, as introduced above, should provide a mechanism for mutual support and cooperation around the production and commercialisation, of key crops and livestock at the local level. Learnings from Innovation Platforms should feed into national-level service delivery coordination, knowledge management and they should provide a space/voice for farmers to influence policy change over the long-term.

#### *6.6.1.1 Strengthen institutional coordination to enable smallholder adaptation to climate change at scale across the three provinces of southern Zimbabwe*

This study has highlighted a series of institutional coordination gaps and barriers, namely: limited coordination between government service providers across levels, limited knowledge management, the interface between service providers and communities, and institutional barriers faced at community level (see Chapter 4). A number of other market-related barriers and a lack of technical capacity compound these and result in fragmented service delivery to farmers. In line with ZimAsset's focus on breaking the 'silo approach', it is recommended that a **national level coordination mechanism is established**, comprising of the primary stakeholder institutions relevant to climate adaptation of agricultural livelihoods in southern Zimbabwe.

It is recommended to establish this as a **national resilience building platform** to ensure a well-coordinated approach to climate resilience across the country and across the agricultural sector. This platform should enable substantive synergies from the various initiatives in resilience building in Zimbabwe (including ZRBF and the proposed GCF project). It is therefore recommended to build on ZRBF structures and to include MLAWCCR, MLAWCCR as well as key development partners (including donors and relevant UN agencies). The platform should enhance coordination and coherence of resilience building initiatives by sharing and utilizing common tools, promoting learning and use of knowledge across interventions, function as a forum for policy dialogue, and harness programmatic synergies and avoiding duplication of the various resilience building initiatives (present and future). Once coordination between key institutions and stakeholders is enhanced, communication and more coordinated sharing of data and information can more easily take place.

At the national level, this study recommends to establish one 'upscaling' **Innovation Platform to manage knowledge and upscale key experiences** from the district level networks of Innovation Platforms. It is recommended that key stakeholders in the project, namely AGRITEX, DR&SS, NEWU, MSD, ZINWA at a minimum, should be part of the upscaling Innovation Platform. At the district level, it is recommended that the establishment of **8 Innovation Platforms, as introduced above (see Section 6.3),** is used to build a learning and knowledge network across the platforms, to avoid duplication and dysfunctional competition, capture economies of scale, facilitate exchange of climate adaptation knowledge and information, and achieve synergies in production, value chain strengthening and market access. The project should build on the valuable experiences and best practice generated by other projects and partners active in climate resilience building efforts.

#### *6.6.1.2 Enhance knowledge management for climate-resilient livelihoods*

Making agricultural production and management systems climate-resilient is a knowledge-intensive process. Therefore, fostering inclusive, effective and innovative knowledge management systems is essential for adoption, replication, and sustainability of CRA practices and the development of climate resilient value chains. This study recommends efforts to focus on the knowledge management gaps identified in DR&SS, AGRITEX and the Agricultural Training Colleges, as key stakeholders in developing CRA interventions in the country. It is recommended to invest in both building the necessary equipment for an effective knowledge management database, as well as facilitating improved organizational structures and coordination around knowledge sharing between collaborating institutions, service providers and farmers and between farmers themselves in order to build and sustain climate resilient livelihoods. Capacity building of three existing (one per province) Agricultural Training Colleges and DR&SS research stations is recommended, to function as centres of excellence that may provide improved training in climate resilient agricultural livelihoods to AGRITEX Extension Officers and farmers.

## 6.7 Addressing gender dimensions

Women constitute the majority of the rural smallholder farming population and are disproportionately affected by climate change impacts given their role in ensuring food production and security and because they have less access to productive assets and resources relative to their male counterparts. The project should include strong gender considerations in the design of interventions in order to address the specific climate-induced vulnerabilities faced by women.

The project may consider to employ a two pronged gender equality and women's empowerment approach. On the one hand, a gender equality approach works towards ensuring that both males and females have equal opportunities. On the other hand, a women's empowerment approach explicitly targets female farmers with support on identified agricultural activities (for instance, extension services targeted to women's routines and needs, particular support to value chains that are traditionally the domain of women, such as the small livestock value chain). It is recommended that the project at minimum mainstreams gender equality principles in the project, includes gender sensitive analysis in the design of interventions and includes gender focused indicators in the projects M&E framework. The project may also consider to explicitly provide project support for women farmers. Such a women's empowerment agenda may be anchored women's groups that are either already existing (women's savings groups or producer groups) or new ones which can be formed around such an initiative.

Based on the gender analysis, this study recommends to:

- Mainstream gender equality principles throughout the project. This entails that gender analysis is taken into account in the design of activities.
- Develop specific strategies to include and target female farmers, in both male and female-headed households for interventions to ensure gender equal participation. This may include review of Constitution and By-Laws for irrigated lands to enhance women's access to land rights and productive resources
- Enhance capacities of both male and female farmers to understand climate change information and use this to inform farming practices and crop/livestock choices
- Build capacities of both male and female farmers in climate resilient agriculture production, with a particular focus on providing extension services to both husband and wife, taking into account women's daily routines and promoting both genders participation in agricultural decision making
- Build capacity of male and female farmers in farming as a business and value addition for irrigation schemes as well as dry land farming. Develop strategies to build capacities of female farmers in particular in leadership and marketing skills
- Monitor gaps in gender equality throughout the project using sex-disaggregated data to support the project to apply strategies to close those gaps
- Advocacy and awareness should be adjusted to most effectively reflect gender-specific differences. Communication strategies used in the project are then tailored, taking into account such differences

## 6.8 Implementation modalities

There is a clear need for a well-coordinated approach across the country and multiple stakeholders to build resilience. The table below details the key stakeholders and responsibilities per intervention component. For overall coordination, it is key to have an overarching coordination framework. It is proposed that rather than establishing a new framework, the project should build on existing frameworks. The ZRBF is the strongest and most comprehensive mechanism for national coordination for resilience building initiatives in agriculture in the country. In consultation with relevant Ministries and development partners, it is proposed that a National Resilience Building Platform is established, building on the existing fund management structures of ZRBF. The platform should include key stakeholders, including MLAWCCR and development partners.

By establishing a National Resilience Building Platform the efforts of ZRBF and the proposed GCF project will promote learning and evidence building across interventions which feed into national level planning and policy for resilience - as well as the shared use of tools and knowledge for interventions for resilience building. The platform will also allow for facilitation of programmatic synergies between the ZRBF and GCF interventions, as well as with other resilience building initiatives (present and future) and serve to avoid duplication of interventions and / or targeting.

It is proposed that the ZRBF Programme Management Unit (PMU) (currently fully funded through a separate EU grant) will become an anchor point for programme and operational support to both the ZRBF and GCF. The GCF project may then support the PMU with proportional funding based on workload estimates and project management costs related to the GCF project. Therefore, rather than duplicating capacity, operational synergies could be found by the establishment of a single PMU. The proposed management structure will also reduce transaction costs for partners (both national and development) and hence further operational synergies will be realized.

Table 23: Overview of stakeholder responsibility per component

| Component | Who | Responsibility |
|---|---|---|
| Irrigation | DoI | Technical design and support to maintenance of irrigation infrastructure |
| | AGRITEX and related departments | Agricultural extension support to smallholder farmers in irrigation schemes |
| | Farmers groups | To operate, maintain and financially upkeep irrigation infrastructure for increased crop production |
| **Component** | **Who** | **Responsibility** |
| CRA | AGRITEX and related departments | Agricultural extension support to smallholder farmers. Agricultural colleges and training institutions to host Innovation Platforms |
| | Department of Livestock | Agricultural extension support to smallholder farmers |
| | DR&SS | Research and knowledge management support to CRA development together with AGRITEX and Department of Livestock. DR&SS research stations to host Innovation Platforms |
| | Capacity development partners | To support capacity building of smallholder farmers in adoption of CRA practices |
| | Research institutions and universities | To contribute to knowledge and evidence base on CRA practices and implementation modalities |
| | Farmers groups | To adopt CRA practices and share learning and experience to other farming communities |
| **Component** | **Who** | **Responsibility** |
| Value chain development and market links | DR&SS | Facilitate innovation platforms with external facilitator and co-develop value chain interventions |
| | Partner in facilitation e.g. relevant research institution or NGO | Facilitate innovation platforms with DR&SS facilitators |
| | Universities and research institutions | To support research and best practice on climate resilient value chains and co-develop value chain and market interventions |
| | Private sector (Input and output market players in a particular value chain) | Participant in Innovation Platforms, facilitating investments and development of value chains in climate resilient and inclusive way |
| | Financial institutions | Participant in Innovation Platforms, facilitating investments for value chain development |
| | Other relevant market players | Participant in Innovation Platforms |
| | Relevant district governance structures, e.g. District Administration and Rural development council | Participant in Innovation Platform, with the aim of facilitating value chain development at district level |

| | | |
|---|---|---|
| | AGRITEX extension service and Agricultural Training Colleges | Participant in Innovation Platforms. Support linking farmers to markets, support farmers in meeting production requirements in contract farming arrangements, support farmers to assess and mitigate climate risks in agricultural production and value chains |
| | Farmers groups | To identify challenges faced in implementing CRA and how to scale up to |
| **Component** | **Who** | **Responsibility** |
| Climate information systems | MSD | Collect climate information and analyse and interpret to turn into climate advisories and disseminate to farmers<br>Maintain climate information equipment and data management systems<br>Collaborate with ZINWA and AGRITEX in producing and disseminating seasonal forecasts and climate advisories to smallholders |
| | WFP | Partner on the implementation of PICSA<br>Coordination on capacity building for enhanced climate information systems and services |
| | ZINWA | Collect hydrological information and distribute for smallholders and Catchment Councils to manage water in a climate smart way and plan for potential climate risks, such as flooding<br>Maintain hydrological information equipment and data management systems<br>Collaborate with MSD and AGRITEX in producing and disseminating seasonal forecasts and climate advisories to smallholders |
| | AGRITEX | Collaborate with MSD and ZINWA to develop agro-hydro-met products for smallholders to support their climate smart agricultural production and water resource management |
| | Capacity building Partners | Build capacity of MSD, ZINWA and AGRITEX in software systems and analysis and interpretation of data for smallholder farmer use. To support the design and delivery of tailored weather and climate products |
| | Farmers groups | Subscribe to weather and climate information services and make use of them in their climate smart agricultural and water management. |
| | Distribution providers | Support developing a cost effective and sustainable system for dissemination |
| **Component** | **Who** | **Responsibility** |
| Institutional coordination | Department of Economics and Markets | Overall project coordination in MLAWCCR |
| | Department of Climate Change Management | Overall project coordination in MLAWCCR |
| | PMU | Responsible for project management |
| | GCF technical committee | Provide technical guidance to project and decision-making on project direction |
| | National Resilience Building Platform board | Provide strategic guidance on resilience building across the country that feeds into GCF project |
| | WFP | Coordination and collaboration on the climate information systems component |

## 6.9 Innovation, cost effectiveness and sustainability of proposed intervention

The proposed intervention is designed to bring new strategies to tackle identified challenges. Innovation, cost effectiveness and sustainability considerations are described below.

### *6.9.1 Innovation*

**A holistic approach, framed by climate risk analysis:** design and implementation is driven by a holistic approach across actors and levels, comprised of key climate resilience components to address climate change impacts. Such an approach recognizes that climate resilient water and agricultural management requires addressing the complex relationships between the environment and socio-economic, political and administrative institutions and their impact on rights and resource access for local communities. It is a shift away from site specific, isolated approaches that tend to address problems in silo.

**Climate resilient approach to irrigation design**: an approach that factors climate change impacts on water and land resources into irrigation design, using hydrological assessments, flood forecasting and tools such as a localised Climate Change Risk Assessment and GESI and political economy assessments. It is based on financial and economic analysis to determine the viability of the schemes, a key aspect of which is the amount of capital needed to ensure sustainable O&M, which will be up-taken by the IMCs overtime. It comprises of a number of complimentary components, including institutional capacity support to build climate risk management into O&M, support to agricultural productivity in the face of a changing climate, and facilitation of off-taker arrangements with agribusinesses in climate resilient value chains.

**Innovation Platforms:** a way of bringing different stakeholders together to identify solutions to common problems or to achieve common goals, as promoted by ICRISAT. They are forums that are, by necessity, multi-stakeholder, used as vehicles to coordinating action and sharing knowledge. Their structure and purpose is flexible allowing platforms to organise around different issues. Through cooperation, a variety of interests are taken into account and dialogue and collaboration encourages confidence among stakeholders. This is particularly valuable between farming and companies when developing climate resilient value chains.

**Integrated and dynamic approach to implementing CRA:** The CRA packages will be implemented through a participatory, 'end-user' centric, learning by doing approach. The experiences from implementing CRA packages will be continuously integrated in the development of climate value chains through Innovation platforms. At the same time, lessons learnt will be up-scaled into policy advice on CRA implementation as well out-scaled through general extension services.

### *6.9.2 Effectiveness*

**Maximum geographical intensity:** The proposed project has targeted districts and wards within a contiguous area to yield maximum impact. This is most suitable for addressing climate change impacts, as these do not respect administrative boundaries and are concentrated, to a certain extent, in areas in terms of similar impacts experienced. Synergies across interventions in close proximity, would encourage cross-fertilisation of impacts and benefits. This will also allow for economies of scale in M&E and implementation support, and will permit synergies among community organisations across the southern provinces.

**Up-scaling a holistic approach:** the interventions mentioned in pervious chapters have successfully implemented elements an approach to increase food and income security of vulnerable smallholders communities in the face of climate risks. At the same time, there has been successful holistic initiatives that provide a technical justification and rationale for upscaling holistic climate resilience building interventions, such as Oxfam and CRIDF (see Chapter 5). By scaling up successful experiences, using lessons learned and best practice, the project expects to achieve transformational change. A holistic approach implemented at scale allows synergies to be created and capitalised on that will increase effectiveness both during and beyond the intervention's lifetime. Efforts implemented at scale provide wider impacts on a national level, increasing efficiencies. For example, a climate information system is unable to work effectively if not institutionalised on a national scale. Economies of scale across project sites in training and capacity building will also increase efficiency. Effective knowledge management allows experiences and learnings to be both up-scaled to policy and out-scaled through extension services and other large-scale intervention.

**Cost-effectiveness:** intervention design has considered the following to achieve maximum cost-effectiveness:

- **Coordinating and synergising with existing efforts:** various consultations with multiple stakeholders were conducted to ensure the proposed interventions can build on and complement donor investments made and results achieved, and prevent overlap and duplication. This was particularly the case with the selection of irrigation schemes, an exercise that was cross-referenced with IFAD and FAO projects and validated with GoZ at the CRA validation workshops. Similarly, the project has coordinated closely with WFP on the design of the climate information services component and it is recommended that WFP takes a role of lead partner on the national roll out of PICSA.
- **Building on best practices and lessons learning:** the project builds on extensive experience of implementing Innovation Platforms in Zimbabwe from ICRISAT and CIMMYT from the CGIAR network, and practical experience from CRIDF in designing and implementing climate resilient irrigation schemes. It also builds on the holistic resilience building efforts from ZRBF and the Scaling up Adaptation project. This means the project has integrated specialised and localised experience. Through the integrated structure of Farmer Field Schools and Innovation Platforms, learning and innovation to continuously seek the most high-impact and appropriate technologoies, practices and mechanisms to action and up-scaling is incorporated into project design, mechanisms that will last beyond the project. Community experience and knowledge will be used to inform investments as a key source of information.
- **Using appropriate technologies and practices:** consultations with communities, key service providers and stakeholders have provided valuable insight into how to ensure proposed investments can be effectively used and adopted by smallholders, and any barriers to adoption were addressed.

- **Benchmarking costs comparable to similar initiatives:** value addition investments and Farmer Field Schools based on existing projects, ZRBF and Scaling Up Adaptation, irrigation investment based on CRIDF, costing of Innovation Platforms based on best practice from ICRISAT experience.
- **Contribution to a larger resilience building framework:** The proposed project will feed into the larger nation wide resilience building framework as provided through the ZRBF. This will allow the project to build on resilience building on the vulnerability analysis, baseline data, experiences and evidence from the ZRBF interventions across the country, as well as allow for project interventions to feed into national evidence building and policy support to resilience building under the ZRBF resilience building framework.

### *6.9.3 Sustainability of proposed interventions*

The factors built into interventions that support sustainability include the following:

- **End-user centric approach in designing and implementing interventions supports ownership and responsibility:** Involving communities' perspectives and experiences encourages empowerment, ownership and increases the likelihood of activities lasting beyond the lifetime of the interventions. This will be the case for the Innovation Platforms in value chain development, as well as in Farmer Fields Schools, where a participatory approach will be used for farmers to choose and select practices that will be sustainable in the particular context. The project will build on existing local structures and encourage community organization and collective management of assets, when investing in community-owned initiatives and infrastructure. This is the case for Irrigation Management Committees, which will support the effective management and sustainability of irrigation schemes over time and when encouraging farmer groups through Farmer Field Schools to invest in collective value addition facilities.
- **Build on and support the existing policy and institutional structures to prevent parallel processes for the roll out of CRA and climate resilient value chains.** The project will make use of the existing capacity building infrastructure through the extension service, this includes the Agriculture Training Colleges, DR&SS research stations and AGRITEX extension service officers at district and ward level. By supporting generation of evidence and knowledge through Innovation Platforms and contributing to improved knowledge management structures in already existing DR&SS and AGRITEX departments and institutions, the project expects that DR&SS and AGRITEX will be better able to support the development of policy and frameworks related to the promotion of CRA and climate resilient value chains at the national level. A stronger link between the decision-makers, researchers and practitioners will support the coordinated development of and budgeting for the promotion of CRA and climate resilient value chain development.
- **Climate resilient infrastructure, designed to withstand climate change impacts**, will make a material difference to many people's lives, providing a more secure supply of water in an area of Zimbabwe where traditional rain-fed farming techniques are already becoming less viable due to climate change. This infrastructure will enable other elements of the potential programme to engage more effectively with both direct beneficiaries and officials, given tangible and concrete results, particularly when advocating for increased efforts to enhance climate information and inter-institutional coordination. The approach is sustainable, primarily because of the following (see Chapter 5 for a more detailed explanation):
  - **Climate resilient design** – builds hydrological assessments, flood forecasting and other tools into design to 'climate-proof' irrigation investments
  - **Financial and economic assessment** – design based on a rigorous analysis to determine the feasibility of the irrigation schemes, including how much upfront capital will be required to cover O&M costs, before
  - **Institutional support to IMCs** – to support implementation in climate-risk informed O&M, community Constitution drafting and set-up of a Maintenance Fund, as well as complementary support in agronomy and market linkages
- **Market driven approach,** which starts from a position of bringing stakeholders together to address shared challenges to effective value chain functioning and inclusive, climate resilient value chain development. Interventions encourage smallholder farmers climate resilient agriculture production based on strategic market linkages, with the aim of incentivising companies to incorporate smallholder farmers into their value chains (to increase their supply) and attract investment (public and private) over the long term to increase the efficiency and climate resilience of value chains (e.g. processing and storage facilities). It is expected that innovation platforms will be continued with government and private contributions after the project investments have ceased, based on a shared need among value chain actors

to continually develop the value chain, adapt to changing climatic conditions as well as market constraints and opportunities. A market driven approach includes the provision of training to smallholder farmers groups in ‘farming as a business’, including skills in market analysis and entrepreneurialism so that farmers organize collectively and increase their income security independently of project interventions over time.

- **Coordinated approach to resilience building:** The implementation modality of the project will support a well-coordinated approach to resilience across the country and across the agricultural sector. The proposed National Resilience Building Platform is established to enable substantive synergies from the various initiatives in resilience building in Zimbabwe (including ZRBF and the proposed GCF project). This platform should include MLAWCCR, MLAWCCR as well as key development partners (including donors and relevant UN agencies such as IFAD, FAO and WFP). The Platform will serve to enhance coordination and coherence of resilience building initiatives by sharing and utilizing common tools (e.g. the multi-hazard map developed by ZRBF to target the most vulnerable), promoting learning and use of knowledge across interventions, harnessing programmatic synergies and avoiding duplication of the various resilience building initiatives (present and future).

# 7 Appendices

## Appendix 1.: Distribution of dams in Zimbabwe

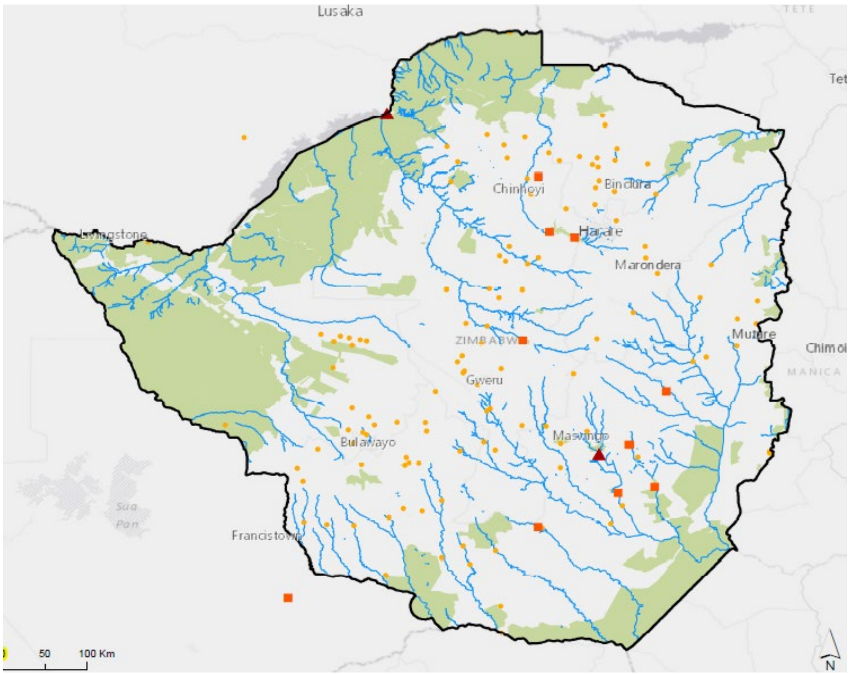



**Figure A1: Distribution of dams in Zimbabwe**
*Source:* Map developed based on data from FAO Aquastat: Geo-referenced database on African dams (http/www.fao.org/nr/water).

## Appendix 2.: An Overview of Zimbabwe's Water Resources

Zimbabwe mostly relies on surface water for important socio-economic activities. Wetlands, groundwater and wastewater are other sources of water. The country is estimated to have total renewable surface water resources in the region of 20 $km^3$/year while internally produced water resources account for 12.26 $km^3$/yr.[371] Potential yield is estimated to be 8.5 $km^3$/yr of which 56% is already committed, with the balance of 3.7 $km^3$ / yr available for irrigation and other uses.[372] The country's dependency ratio is 38.7% because it shares a number of transboundary water bodies with its neighbours.[373]

Water distribution varies between the country's seven catchments (Figure A2) as revealed by Mean Annual Runoff (MAR) and Coefficient of Variation (CV) as shown in Table A1. Low CVs are found in sub-zones where rainfall is high, e.g. in the Eastern Highlands where rainfall amounts of 1,500 mm per year are received.[374] About 12% of the average rainfall received in Zimbabwe is converted to runoff in rivers after accounting for interception, evaporation and infiltration. Catchments that are located in high rainfall areas such as Mazowe generate the highest unit runoff of 131 mm while the Gwayi and Mzingwane catchment, with the least rainfall, generate 21 and 28 mm respectively.[375] Between 1984 and 2007, national average runoff coefficient increased by 18%[376] which was attributed to drought occurrence, land-use changes and poor assessment methods.[377] There is a view that assessment can be enhanced if better methods and analytical tools, such as Geographic Information Systems (GIS) and Remote Sensing are used.[378]


[371] FAO, 2011, FAOSTAT, http://www.fao.org/countryprofiles/index/en/?iso3=ZWE
[372] Ibid.
[373] Ibid.
[374] ZINWA. 2009. Assessment of surface water resources of Zimbabwe and guidelines for planning. Harare, Zimbabwe.
[375] Ibid.
[376] Ibid.
[377] Murungweni, Z. 2011. Warer resources, use, demand, planning and financing, Thematic Paper 2. Background paper on Water resources development and management for the Zimbabwe National Water Policy, Harare, Zimbabwe.
[378] Ibid.

**Figure A2. Catchment and sub catchments of Zimbabwe**

Water storage is critical in areas that have low MAR and high CV such in Runde and Mzingwane river basins. Over the years Zimbabwe has invested in water storage and ranks second to South Africa within the Southern African Development Community (SADC) with respect to per capita storage.[379] The country boasts of many large, medium- and small dams that were constructed for urban, agriculture, mining and industrial uses with a total storage capacity amounts to 8.75 x $10^6$ $Mm^3$ with a 10 per cent annual yield of 3.67 x $10^6$ $Mm^3$ as indicated in Table A1[380]. Storage facilities can be constructed to double the amount of MAR to 47.2 x $10^6$ $Mm^3$ allowing for good years when more than average runoff is realized, which can also be used to increase the yield of the reservoirs. Save, Runde and Mzingwane catchment have the least quantity of stored water as well as the least storage potential (Tables A1 and A2).

**Table A1. Available water resources and developed capacity by catchment.**

| **Catchment** | **MAR ($10^6$ $m^3$)** | **MAR (mm/year)** | **CV (%)** | **Potential Storage at 2 x MAR ($10^6$ $m^3$)** | **Developed storage ($10^6$ $m^3$)** |
|---|---|---|---|---|---|
| Gwayi | 1.8 | 21 | 140 | 3.7 | 0.2 |
| Manyame | 3.3 | 82 | 112 | 6.6 | 2.6 |
| Mazowe | 4.6 | 131 | 101 | 9.2 | 0.3 |
| Mzingwane | 1.8 | 28 | 140 | 3.4 | 1.3 |
| Runde | 2.1 | 52 | 133 | 4.3 | 2.5 |
| Sanyati | 3.9 | 52 | 114 | 7.8 | 0.6 |
| Save | 6.1 | 126 | 99 | 12.2 | 1.2 |
| **Total** | **23.7** | **61** | **122** | **47.2** | **8.7** |

*Source:* ZINWA (2009)

**Table A2. Distribution of dams in Zimbabwe according to size and catchment.**

| **Storage size ($10^3$$m^3$)** | **Gwayi** | **Sanyati** | **Manyame** | **Mazowe** | **Save** | **Runde** | **Mzingwane** | **Total** |
|---|---|---|---|---|---|---|---|---|
| 10 | 9 | 27 | 48 | 71 | 37 | 12 | 11 | 215 |
| 100 | 69 | 170 | 266 | 286 | 151 | 70 | 67 | 1, 079 |
| 1,000 | 92 | 262 | 411 | 340 | 175 | 101 | 89 | 1, 470 |
| 10,000 | 20 | 91 | 154 | 137 | 60 | 28 | 42 | 532 |
| 100,000 | 4 | 6 | 11 | 10 | 5 | 13 | 10 | 59 |
| 1,000,000 | 2 | 1 | 6 | 0 | 3 | 1 | 2 | 15 |
| 2,000,000 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 2 |
| **Total** | **196** | **558** | **896** | **844** | **431** | **226** | **221** | **3, 372** |

*Source:* ZINWA (2009)

There are many small dams in the rural areas many of which were built by Government and Non-Governmental organizations under the one dam per district campaign in the 1990s as a response to droughts.[381] While these are an important source of water for domestic use, livestock watering and for small-scale irrigation, they tend to be poorly managed, and are have either been silted up or are in danger of doing so[382].

[379] Manzungu, E. 2011. Reviving irrigation development and management. Thematic Paper 3 Background paper on Water resources development and management for the Zimbabwe National Water Policy, Harare, Zimbabwe.
[380] GoZ. 2013a. National Water Policy, Ministry of Water Resources Development and Management, Harare, Zimbabwe.

[381] Bahal'okwibale Mulengera, P. Manzungu, E and Kileshye Onema, J. 2012. ICT-Based Identification and Characterisation of Small Reservoirs in the Limpopo River Basin in Zimbabwe, *Environment and Natural Resources Research* 2(3). pp. 25-42.
[382] Ibid.

Wetlands are another important source of water and are commonly refer to *dambos (*seasonally waterlogged headwater wetlands that are common in southern Africa.[383] It is estimated that wetlands cover about 1.28 million hectares[384] of which 25% are found in communal areas where they are used for vegetable and field crop production on some 20,000 hectares and contribute greatly to food security.[385]

In general, Zimbabwe has limited groundwater resources due weathered and fractured crystalline rock formations of the basement complex that underlies more than 60% of the country.[386] Total groundwater potential in the country is estimated to be 3.0 x $10^6$ $Mm^{3.}$ Some 1.0 x$10^6$ $Mm^3$ of groundwater is estimated to be in use although this figure may underestimate current water use because of limited information on usage.[387] Groundwater is used for public and private drinking water supply, agricultural and industrial purposes, maintenance of flow and water levels in rivers, lakes and wetlands, particularly during times of low rainfall. It is also the main source for domestic use and livestock watering in rural areas and is a crucial source of domestic and small scale irrigation water in rural areas (where the majority of the country's population is found) and in many cases is the only affordable and sustainable means to improve access to clean water in rural areas.[388] Climate change is likely to negatively affect surface and groundwater resources and this will have a significant impact on the performance of investments in water infrastructure.

Treated wastewater has been used to complement surface and groundwater in industry and for irrigation. Historically the country used to recycle over 480 Ml/day of treated wastewater before the breakdown of wastewater treatment facilities, and some 0.365 x $10^6$ ML/annum of treated wastewater was available from major urban areas in 2012 for irrigating food crops and pastures.[389] However, poor quality effluent is harmful the environment due to heavy metal accumulation, spread of pathogens and biological contaminants.[390]

[383] Matiza. T. and Crafter, S.A. (eds.) (1994). *Wetlands Ecology and Priorities for Conservation in Zimbabwe: Proceedings of a Seminar on Wetlands Ecology and Priorities for Conservation in Zimbabwe.* Kentucky Airport Hotel, Harare, 13-15 January, 1992. 170 pages.

[384] Owen. R., Verbeek, K., Jackson, J. and Steenhuis, T. (eds.) (1995). *Dambo Farming in Zimbabwe: Water Management, Cropping and Soil Potentials for Smallholder Farming in the Wetlands.* University of Zimbabwe Publications, Harare.

[385] Ibid.

[386] MacDonald, A.M., Davies, J. and Calow, R.C. 2008. African hydrogeology and rural water supply. In: Segun. A. MacDonald, A. (Eds.) *Applied ground water studies in Africa*. London. CRC Press. 127-148.

[387] GoZ. 2013a. National Water Policy, Ministry of Water Resources Development and Management, Harare, Zimbabwe.

[388] MacDonald, A.M., Davies, J. and Calow, R.C. 2008. African hydrogeology and rural water supply. In: Segun. A. MacDonald, A. (Eds.) *Applied ground water studies in Africa*. London. CRC Press. 127-148.

[389]GoZ. 2013a. National Water Policy, Ministry of Water Resources Development and Management, Harare, Zimbabwe.

[390] Masona, C., Mapfaire, L., Mapurazi, S., and Makanda, R. 2011. Assessment of heavy metal accumulation in wastewater irrigated soil and uptake by maize plants (Zea mays, L.) at Firle Farm in Harare, *Journal of Sustainable Development,* 4(6), 132-137.

## Appendix 3.: Livelihood Zones in southern provinces

In 2011, the Zimbabwe Vulnerability Assessment Committee (ZIMVAC) embarked on the analysis of livelihoods across Zimbabwe to address knowledge gaps in terms of livelihoods of poor populations. The livelihoods analysis provided an approach to strengthen its analysis of dynamics of change and vulnerability within household and has informed programming and policy to reduce vulnerability. Below, the livelihood zones are mapped out for the whole country, followed by a summary of livelihood zones across the southern provinces.

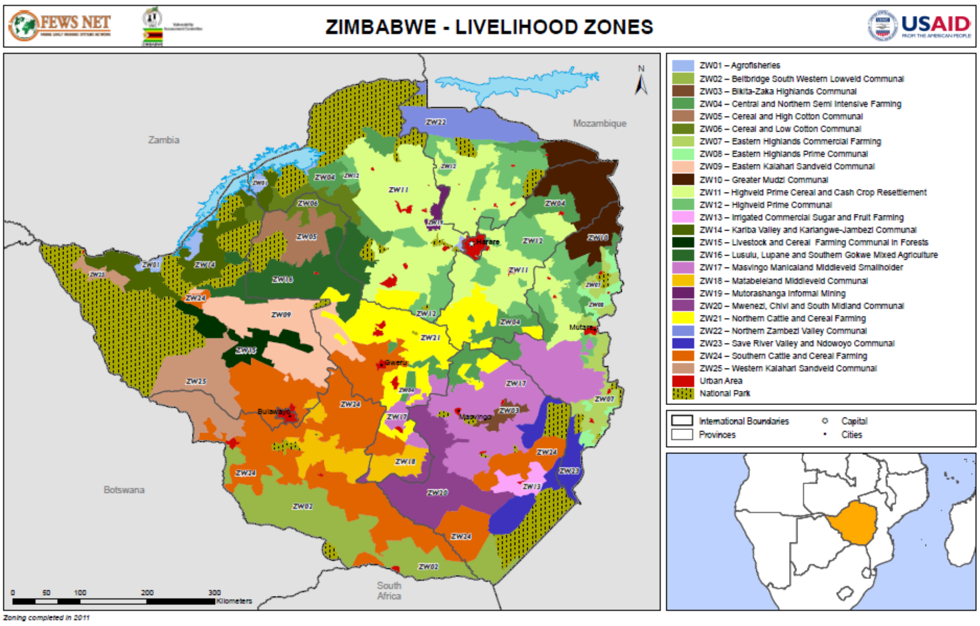



**Figure A3: Part of Livelihoods Zoning Map (cropped to focus on southern provinces)** *Source:* USAID, FEWS, ZimVAC 2011

**Table A3: Summary of livelihood zones in southern provinces**

| Area | Districts covered | Description of livelihoods zone |
|---|---|---|
| ZW 18 - Matabeleland Middle Veld communities. | The zone covers low lying areas and some mountainous parts of Matobo, Gwanda, and Umguza, Bubi, Umzingwane, Insiza and Mberengwa. | Livelihoods in this zone are mainly characterised by animal husbandry (small and big livestock) and rain-fed cultivation of maize, sorghum, pulses and sweet potatoes. Poor farmers depend partly on their own crop production and to a larger extent on cash income earned from local and cross border employment, trade, beer brewing or gold panning on the various rivers. |
| ZW 24 - Southern Cattle and Cereal Farming | This livelihood zone spread across 15 districts, incl. Mangwe, Matobo, Gwanda, Beitbridge, Mwenezi | This is a predominantly mixed farming area with cereal cropping and cattle ranching. The majority of farmers are A1 and A2 farm beneficiaries, who will not be targeted by the proposed project. Production of maize, sorghum, and groundnuts, round nuts, cowpeas and sweet potatoes is moderate. This is a food secure zone. |
| ZW 20 - Mwenezi, Chivi and South Midland Communal | This zone covers communal lands across the districts of Mwenezi, Chivi, Southern Mberengwa and Western Masvingo. | Small holder farmers combine cereal and cash cropping with livestock production and market purchases. Casual work opportunities are found on plantations, estates and mines within the zone as well as further afield. Crop production is a precarious venture in this lowland area and the zone is an area of chronic poverty and food insecurity. |
| ZW 02 - Beitbridge South-Western Lowveld Communal | The zone shares the border with South Africa and Botswana in the southern parts of Beitbridge, Gwanda, | Semi-arid zone heavily dependent on livestock production as harsh climatic conditions restrict crop production activities. Employment is also a key source of food and cash income. Proximity to A2 farms, commercial estates and job markets around the border with South Africa and Botswana provides employment opportunities. Sorghum cropping, mopane worm sales and gold panning supplement wage earnings of the poor. |

| | | |
|---|---|---|
| | Matobo, Mangwe, and Chiredzi districts | |
| ZW 03 - Bikita Zaka Highlands | This zone covers communal lands in the north-east of Masvingo, Zaka north and Bikita west districts. | Semi-Intensive farming region. Maize and groundnuts provide better-off farmers with a stable source of food and cash income. Poor farmers tend to combine maize and agriculture labour opportunities with (limited) gold panning and local employment (such as in the Bikita mines). The area has fertile soils, with potential for improved crop production. High population density and small farm sizes are the biggest constraints to increased crop production. |
| ZW 17 - Masvingo, Manicaland Middleveld Smallholder | This zone stretches across Buhera, Bikita, Zaka, Masvingo districts, among others. | Livelihoods in this zone are characterised by cereal agriculture supplemented by cash cropping (groundnuts, round nuts and cotton), animal husbandry and remittances from migratory labour. A number of other income sources help the poor make ends meet including: sales of wild fruits and vegetables, gold panning, legal gold and diamond mining, sales of beer and handicrafts, cross border trade and casual labour. |
| ZW 23 - Save River Valley and Ndowoyo Communal | The zone is located in south-eastern Zimbabwe, covering parts of Chipinge, Chiredzi and Bikita districts. | This dry, lowland area is primarily agricultural. Households grow mainly small grains (sorghum and millet) as well as maize and groundnuts. The zone has good soils, but cropping is limited by erratic rainfall. Consequently, cash income earned through seasonal casual work, petty trading and the sale of handicrafts, goats and some cotton is fundamental to the food economy. Remittances are also important. |
| ZW 13 - Irrigated Commercial Sugar and Fruit Farming | South-eastern Zimbabwe, mainly Chiredzi | Livelihoods for small holders in this arid zone are based on livestock and cereal production. Cereal production is primarily small grains, and legumes such as groundnuts, round nuts, and cowpeas. Maize is also widely grown, despite the harsh climatic conditions. Cotton is the main cash crop, which is supplemented by income from animal husbandry. Residents of this zone also include households who live and work permanently on the irrigated commercial sugar and fruit estates in Triangle and Hippo Valley, as well as some smallholder (A1) resettled farmers (not targeted in this project proposal). The commercial farm workers depend on wage earnings and petty trade income to secure their food needs. |
| ZW 07 - Eastern Highlands Commercial Farming | The zone covers parts of Nyanga, Chimanimani, Chipinge and Mutasa districts of Manicaland Province. | This high potential zone produces fruit, vegetables, flowers, tea, coffee and sugar cane for export. Timber is an important industry in this rugged, forested Highveld zone. Both the commercial farms and the saw mills offer labour opportunities to poor farmers as well as to farm-workers (who often need to pick up additional work to supplement on-farm income). |
| ZW 08 - Eastern Highlands Prime Communal | This livelihood zone is in Manicaland province and covers Nyanga, Mutasa, Chimanimani, and Chipinge districts. | This is a high potential zone where the greater part of available land is classified as some of the most productive communal land. It is characterized by intensively farmed small plots of mixed food and cash crops. Maize is primary but crop diversity is a key feature here (cereals, root crops, fruits, tea/coffee, tobacco). Poor farmers find wage work locally in the commercial agriculture sector. |

*Source: ZimVAC 2011*

## Appendix 4.: Impacts of climate change on precipitation, Mean Annual Runoff (MAR) and groundwater in Zimbabwe

A World Bank study increased and improved the knowledge base in Zimbabwe regarding the impacts of climate change at the national level. The study drew upon the work done for the National Climate Change Response Strategy (NCCRS) which modelled precipitation and runoff in Zimbabwe's seven catchments using the CSIRO Mk3 global circulation model under A2a and B2A scenarios[391]. The projected rainfall patterns as measured by Mean Annual Precipitation (MAP) is shown in Table A4.

**Table A4: Estimated current, 2050 and 2080 MAP (mm) in Zimbabwe catchments under two emissions scenarios**

| Catchment | Current | | 2050 Business as usual scenario (A2a) | 2050 Ecologically aware scenario (B2a) | 2080 Business as usual scenario (A2a) | 2080 Ecologically aware scenario (B2a) |
|---|---|---|---|---|---|---|
| | Observed | World Climate Data | | | | |
| Gwayi | 599 | 605 | 545(10%) | 576 (5%) | 515 (15%) | 587 (3%) |
| Manyame | 709 | 785 | 769 (2%) | 795(-1%) | 757 (4%) | 800 (-2%) |
| Mazowe | 824 | 915 | 854 (7%) | 907 (1%) | 864 (6%) | 899 (2%) |
| Mzingwane | 547 | 506 | 430 (15%) | 447 (12%) | 379 (25%) | 445 (12%) |
| Runde | 606 | 706 | 592(16%) | 622 (12%) | 534 (24%) | 616 (13%) |
| Sanyati | 635 | 738 | 684 (7%) | 716 (3%) | 655 (11%) | 723 (2%) |
| Save | 815 | 915 | 784(14%) | 839 (8%) | 756(17%) | 832(9%) |

Source: Davis and Hirji (2014) Percentage decreases in MAP are shown in brackets. A negative percentage indicates an increase in rainfall.

The following were noted:

- By 2050 and 2080, under both emission scenarios, MAP is predicted to decrease in all catchments, except for Manyame where it could increase slightly under the ecologically aware scenario.
- The most affected catchments are in the south of Zimbabwe (in Mzingwane and Runde catchments) where MAP could decline by 12-16% by 2050 and by 1225% by 2080.
- MAP is likely to remain relatively constant in the northwest of the country (Manyame and Mazowe catchments)
- MAP could stabilize or start to recover in the more affected catchments (Gwayi, Mzingwane, Runde, Sanyati and Save) between 2050 and 2080 under the ecologically aware emissions scenario, although it would continue to decline in almost all catchments if the "business as usual" emissions scenario is maintained.
- Decreases in precipitation are significant a 15% decrease in Mzingwane catchment by 2050 under the business as usual case, or a 12% decrease even if the world adopts ecologically aware growth patterns.
- The pattern of a decline in MAP across western and southern Zimbabwe to 2050 with continuing precipitation declines to 2080 if emissions of greenhouse gases are not curbed.

Table A5 shows patterns as far as potential changes in MAR in the seven catchments are concerned.

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[391] A2a describes a heterogeneous world of independent nations with regionally oriented economies. The main driving forces are a high rate of population growth, increased energy use, land-use changes and slow technological change (business as usual scenario). B2a describes a regionally oriented world with local rather than global solutions to economic and environmental sustainability. Population is still growing but less rapidly than in A2a and there are more diverse technological changes and slower land-use changes (ecologically aware scenario).

**Table A5: Estimated current, 2050 and 2080 MAR in Zimbabwean catchments under two emissions scenarios**

| Catchment | Current (World Climate data) | 2050 Business as usual scenario (A2a) | 2050 Ecologically aware scenario (B2a) | 2080 Business as usual scenario (A2a) | 2080 Ecologically aware scenario (B2a) |
|---|---|---|---|---|---|
| Gwayi | 2,088 | - | 1,047 (50%) | - | 1,432 (31%) |
| Manyame | 4,496 | 4,244 (6%) | 4,661 (-4%) | 4,046 (10%) | 4,736 (-5%) |
| Mazowe | 5,665 | 4,825 (15%) | 5,559 (2%) | 4,974 (12%) | 5,443 (4%) |
| Mzingwane | 1,082 | - | 379 (65%) | - | 356 (67%) |
| Runde | 3,530 | 1,967 (44%) | 2,343 (33%) | 1,311 (63%) | 2,271 (36%) |
| Sanyati | 6,905 | 5,314 (23%) | 6,248 (10%) | 4,483 (35%) | 6,471 (6%) |
| Save | 8,010 | 5,455 (32%) | 6,558 (18%) | 4,970 (38%) | 6,414 (20%) |

Source: Davis and Hirji (2014)

Percentage decreases in MAR are shown in brackets. A negative percentage means runoff is predicted to increase.

The following trends were noted:

- There is a proportionately greater decline in runoff than in precipitation.
- There is a particularly sharp decline in runoff in Gwayi, Mzingwane and Runde catchments under both scenarios, to the point where the calculated MAR drops to zero in Gwayi and Mzingwane catchments under the "business as usual" scenario in both 2050 and 2080.
- There is likely to be a large decline in MAR across western and southern Zimbabwe to 2050 with continuing declines to 2080 if emissions of greenhouse gases are not reduced.

Table A6 shows groundwater recharge patterns using what the authors called a simple approach. The change in recharge will be directly proportional to the change in precipitation under the two climate change scenarios. Groundwater recharge is least affected by climate change in the north of Zimbabwe and most affected in the dry southern catchments of Mzingwane and Runde. The study, however, conceded that the assessment was not conclusive.

**Table A6: Estimated groundwater recharge (Gl/yr) for Zimbabwean catchments**

| Catchment | Recharge as % MAP | Current | 2050 Business as usual scenario (A2a) | 2050 Ecologically aware scenario (B2a) | 2080 Business as usual scenario (A2a) | 2080 Ecologically aware scenario (B2a) |
|---|---|---|---|---|---|---|
| Gwayi | 3% | 1596 | 1438 (10%) | 1520 (5%) | 1359 (15%) | 1549 (3%) |
| Manyame | 6% | 1907 | 1868 (2%) | 1932 (-1%) | 1839 (4%) | 1944 (-2%) |
| Mazowe | 6% | 1918 | 1791 (7%) | 1901 (1%) | 1811 (6%) | 1844 (2%) |
| Mzingwane | 2% | 632 | 537 (15%) | 558 (12%) | 473 (25%) | 556 (12%) |
| Runde | 5% | 1449 | 1215 (16%) | 1277 (12%) | 1096 (24%) | 1265 (13%) |
| Sanyati | 5% | 2750 | 2549 (7%) | 2668 (3%) | 2441 (11%) | 2694 (2%) |
| Save | 6% | 2660 | 2279 (14%) | 2439 (8%) | 2197 (17%) | 2418 (9%) |

*Source:* Davis and Hirji (2014)
Percentage decreases in recharge are shown in brackets. A negative percentage means that recharge is predicted to increase.

Further insights were provided by a World Bank study carried out in support of the National Climate Policy[392]. Three quarters of the 121 models indicate negative changes in runoff across all the basins with the drier basins, such as in Mzingwane and Runde, projected to experience very large ranges with larger spans in both positive and negative directions (up to 74% difference between the 10th and 90th percentile) across the 121 climate change scenarios (Figure A8). The mean changes in runoff across the 121 projections range from a reduction of 35% in Gwayi to a reduction of 15% in Mzingwane. The 25th to 75th percentiles, on the other hand, range from reductions of over 60% to 7% increases in Gwayi and Mzingwane, respectively.

[392] World Bank (2015), Supporting Zimbabwe's climate resilience agenda: Background notes in support of the National Climate Policy, including Note A: Agriculture; Note B: Water; Note C: Climate Resilient Infrastructures; Note D: Forests; Note E: Technical Appendix on Climate Change Scenarios.

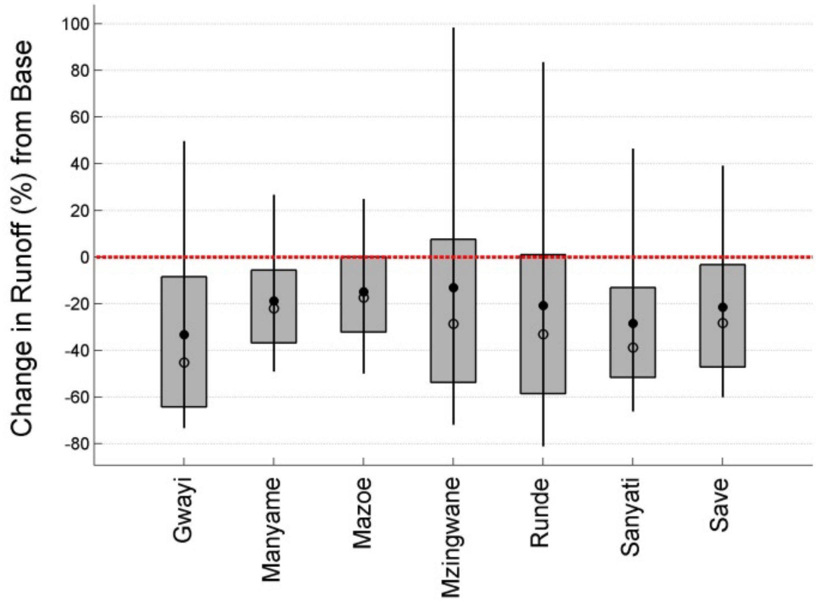


**Figure A4. Per cent deviation in runoff from 1950-1999 to 2041-2050 period for all Zimbabwean basins**
*Source:* World Bank (2015)

For PET all the 121 scenarios show a positive change with a narrower range of 50% between the 10th and 90th percentile (Figure A5).The average changes range from an increase of 8% in Save to an increase of 11% in Gwayi.

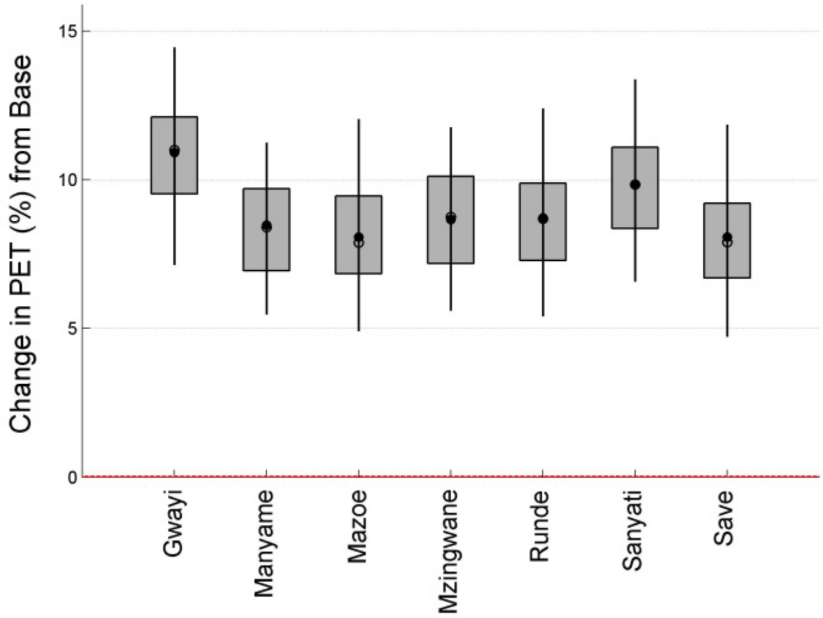


**Figure. A5: Per cent deviation in potential evapotranspiration (PET) from 1950-1999 to 2041-2050 period across all Zimbabwean basins (Source: World Bank, 215)**

Note: these boxplots show the span of projected changes across the 121 climate scenarios in each of the seven basins between the 1950-1999 baseline and the 2041-2050 period. The box spans the 25th to 75th percentiles, and the whiskers span the 5th to 95th percentiles; the solid circle is the mean and the open circle is the median.

## Appendix 5.: Annual average sediment load in selected rivers and stations in Zimbabwe

| Catchment | Station | Catchment Area | Name/Location | River | Annual Average Sediment Load/tonnes | Annual Average Sediment Load in tonnes per km^2 |
|---|---|---|---|---|---|---|
| Gwayi | A36 | 17200 | Gwayi Confluence Flume | Shangani | 602,672 | 35.0 |
| Manyame | C64 | 9744 | Nyakapupu | Manyame | 51,865 | 5.3 |
| Mazowe | D6 | 1170 | Mutoko Road Bridge | Shavanhohwe | 19,652 | 16.8 |
| Mazowe | D42 | 163 | Mupfurudzi u/s g/w | Mupfurudzi | 8,121 | 49.8 |
| Mazowe | D48 | 399 | Mwenje dam u/s g/w | Mwenje | 1,525 | 3.8 |
| Mazowe | D59 | 1103 | Ruya Falls Flume | Ruya | 930 | 0.8 |
| Mazowe | D75 | 20380 | Old Mazowe Bridge | Mazowe | 1,023,364 | 50.2 |
| Mazowe | DGP41 | 230 | Chivake g/w | Chivake | 14,072 | 61.2 |
| Mzingwane | B20 | 2530 | Glass Block | Mzingwane | 2,382 | 0.9 |
| Mzingwane | B66 | 673 | Silalabuwa Dam u/s | Kangesi | 1,562 | 2.3 |
| Mzingwane | B94 | 3969 | Manyuchi dam u/s gw | Manyuchi | 34,159 | 8.6 |
| Runde | E45 | 847 | Mutirikwe dam u/s | Mutirikwe | 2,278 | 2.7 |
| Runde | E176 | 7295 | Tokwe Dam u/s | Tokwe | 156,726 | 21.5 |
| Runde | E83 | 17100 | Tokwe confluence | Runde | 352,949 | 20.6 |
| Runde | E117 | 1090 | muzhwe Dam u/s | Ngezi | 31,837 | 29.2 |
| Runde | E108 | 1041 | Manjirenji Dam u/s | Chiredzi | 8,594 | 8.3 |
| Sanyati | C6 | 1040 | Ngezi dam u/s gw | Ngezi | 4,595 | 4.4 |
| Sanyati | C67 | 3650 | Maynard weir u/s gw | Mupfure | 9,467 | 2.6 |
| Save | E19 | 3320 | Condo u/s g/w | Macheke | 16,404 | 4.9 |
| Save | E21 | 11000 | Condo d/s g/w | Save | 136,791 | 12.4 |
| Save | E130 | 7324 | Odzi Gorge G/w | Save | 426,628 | 58.3 |
| Save | E62 | 1990 | Buhera g/w | Nyazvidzi | 16,949 | 8.5 |
| Save | E118 | 8200 | Chisurgwe | Dewure | 425,439 | 51.9 |
| Save | E120 | 150 | Nyanyadzi Dam u/s | Biriwiri | 2,198 | 14.7 |
| Save | F22 | 644 | Katiyo | Pungwe | 58,124 | 90.3 |
| Save | E61 | 2450 | Odzi Bridge C/Section | Odzi | 119,958 | 49.0 |

Source: Pre-feasibility study, 2016

## Appendix 6.: Analysis of siltation rates in selected surveyed dams in Zimbabwe

| CATCHMENT | NAME OF DAM | YEAR BUILT | YEAR SURVEYED | No of YEARS | OLD CAPACITY x10^6m^3 | NEW CAPACITY x10^6m^3 | % SILTATION | Annual Average Rate of Siltation as a % |
|---|---|---|---|---|---|---|---|---|
| SANYATI | BLINKWATER | 1910 | 1986 | 76.0 | 400.0 | 231.3 | 42.2 | 0.6 |
| MZINGWANE | ANTELOPE | 1971 | 1989 | 18.0 | 14.6 | 12.5 | 14.1 | 0.8 |
| MAZOWE | MWENJE | 1966 | 1989 | 23.0 | 38.0 | 36.4 | 4.2 | 0.2 |
| MZINGWANE | MZINGWANE | 1958 | 1990 | 32.0 | 43.8 | 42.8 | 2.2 | 0.1 |
| MZINGWANE | UPPER MUJENI | 1946 | 1990 | 44.0 | 1.1 | 0.7 | 42.7 | 1.0 |
| MZINGWANE | TULIMAKWE | 1966 | 1991 | 25.0 | 8.3 | 6.2 | 25.8 | 1.0 |
| MAZOWE | NYAMBUYA | 1959 | 1992 | 33.0 | 2.3 | 2.1 | 6.0 | 0.2 |
| MZINGWANE | UMHLANGWA | 1971 | 1992 | 21.0 | 4.3 | 4.3 | 0.7 | 0.0 |
| MZINGWANE | UPPER NCEMA | 1973 | 1994 | 21.0 | 45.5 | 43.6 | 4.1 | 0.2 |
| MZINGWANE | INYANKUNI | 1964 | 1994 | 30.0 | 81.7 | 81.4 | 0.4 | 0.0 |
| MZINGWANE | LOWER NCEMA | 1943 | 1995 | 52.0 | 18.2 | 15.0 | 17.9 | 0.3 |
| GWAYI | SHANGANI | 1972 | 1996 | 24.0 | 14.4 | 13.4 | 7.2 | 0.3 |
| GWAYI | UMGULULU | 1954 | 1996 | 42.0 | 2.1 | 2.0 | 7.3 | 0.2 |
| GWAYI | MAMANDE | 1967 | 1997 | 30.0 | 11.9 | 11.8 | 0.8 | 0.0 |
| MZINGWANE | UPPER INSIZA | 1967 | 1997 | 30.0 | 9.1 | 7.9 | 13.8 | 0.5 |
| MZINGWANE | MADABE | 1966 | 1998 | 32.0 | 1.4 | 0.0 | 98.0 | 3.1 |
| GWAYI | EXCHANGE | 1972 | 1999 | 27.0 | 16.7 | 14.5 | 13.5 | 0.5 |
| RUNDE | NYAJENA | 1957 | 2002 | 45.0 | 8.4 | 4.7 | 55.5 | 1.2 |
| MAZOWE | CHESA | 1991 | 2003 | 12.0 | 1.2 | 0.6 | 46.7 | 3.9 |
| MAZOWE | CHIMANDA | 1988 | 2003 | 15.0 | 5.2 | 3.5 | 33.3 | 2.2 |
| MAZOWE | NYADIRE | 1988 | 2004 | 16.0 | 1.6 | 1.1 | 32.9 | 2.1 |
| MAZOWE | KOTWA | 1975 | 2004 | 29.0 | 1.0 | 0.7 | 27.7 | 1.0 |
| MAZOWE | NYAMAPANDA | 1970 | 2004 | 34.0 | 0.5 | 0.2 | 55.8 | 1.6 |
| MAZOWE | CHITISA | 1973 | 2004 | 31.0 | 2.3 | 1.5 | 33.6 | 1.1 |
| MAZOWE | CHIKONO | 1978 | 2005 | 27.0 | 0.4 | 0.4 | 8.7 | 0.3 |
| MAZOWE | CHIVAKE | 1974 | 2005 | 31.0 | 3.4 | 2.0 | 39.8 | 1.3 |
| MAZOWE | MUTIRINGINDI | 1980 | 2006 | 26.0 | 0.9 | 0.8 | 11.4 | 0.4 |
| MAZOWE | KEMPHAVEN | 1978 | 2006 | 28.0 | 1.3 | 0.7 | 43.8 | 1.6 |
| MAZOWE | MUFURUDZI | 1968 | 2006 | 38.0 | 12.2 | 9.9 | 18.9 | 0.5 |
| MANYAME | PEMBI | 1962 | 2007 | 45.0 | 2.3 | 2.2 | 1.7 | 0.0 |
| MANYAME | CLEVELAND | 1912 | 2010 | 98.0 | 0.9 | 0.9 | 2.4 | 0.0 |
| RUNDE | KHUMALO WEIR | 1953 | 2010 | 57.0 | 1.2 | 0.7 | 44.0 | 0.8 |
| SANYATI | MUTANGI | 1942 | 2011 | 69.0 | 110.0 | 96.6 | 12.1 | 0.2 |

Source: Pre-feasibility study, 2016

## Appendix 7.: Overview of Smallholder Irrigation in Zimbabwe

**1. Structure of the irrigation subsector**

The structure of the irrigation sector is in many ways a microcosm of the country's history. Before independence, the irrigation subsector was developed along racial lines just as was the case with other economic spheres. On one side was individual- and estate commercial irrigation and on the other subsistence-oriented smallholder irrigation subsector. Both individual- and estate-owned commercial irrigation was developed on the back of a strong state-subsidized funding.[393]

The face of the irrigation sector was dramatically changed as a result of the fast track land reform programme particularly large scale commercial irrigation. Before the fast track land reform large scale commercial (incorporating individually owned and estates) constituted 80% by area while the Agricultural Rural and Development Authority (ARDA) and communal irrigation each accounted for around 10 per cent of the area. After the fast track land reform programme, the private large scale commercial subsector virtually ceased to exist as an entity as it became A1 and A2 farmland. The irrigated area that falls under A1 and A2 is facing many operational challenges. Some of the challenges emanated from the fact that many farmers are sharing an irrigation system that was meant for a single user without any clarity on how this could be re-designed of the schemes to suit the new reality. There were also no arrangements for sharing water and electricity costs. Another problem is that irrigation infrastructure estimated to be in the region of 50,000-70 000 ha was damaged. For example, while ARDA has 15,000 ha of equipped irrigated area only 7,000 ha is currently being irrigated. The rest needs to be rehabilitated. ARDA has also not managed to expand to realize its potential of 25,000 ha.

As was the case with commercial irrigation, irrigation in the communal and old resettlement areas was also affected by the challenging socio-economic environment. Apart from rehabilitation challenges, there is consensus that the performance of the subsector needs to be improved, which is affected by poor state of infrastructure, poor water management and low agricultural production. The result has been that the subsector has been and continues to be subsidised. The dependence of the state explains why there is still water reserved for irrigation in communal farmers in government dams (Table A7).

**Table A7: List of state dams/schemes with water reserved for smallholder irrigation in Zimbabwe**

| Catchment | Name of dam/scheme | Area (ha) | Total area per catchment (ha) |
|---|---|---|---|
| Mazowe | Mufurudzi | 35 | 165 |
| | Banana | 50 | |
| | Dzvete | 30 | |
| | Mutawatawa | 20 | |
| | Evergreen | 30 | |
| Sanyati | Seke Sanyati | 100 | 416 |
| | Makwavarara | 300 | |
| | Negande | 16 | |
| Mzingwane | Mtshabezi | 300 | 784 |
| | Maribeha | 234 | |
| | Manyuchi | 228 | |
| | Muchembere | 22 | |
| Runde | State Conservancy | 10 000 | 10, 742 |
| | Ngwane Ranch | 200 | |
| | Mbindangombe | 150 | |
| | Nyahombe | 178 | |
| | Matezva | 60 | |
| | Machena | 100 | |
| | Mashaya-Bangala | 54 | |
| Save | Osborne | 2 000 | 2,600 |
| | Marange II | 500 | |
| | Mukwanda | 100 | |
| Total | | 15, 067 | |

[393] Manzungu, E. and Machiridza, R.. 2009. Economic-legal ideology and water management in Zimbabwe. *Economics, Management and Financial Markets* 4(1). 66-102.

Source: Utete (2003)[394]

In all the three provinces that form southern Zimbabwe, rain fed crop production and livestock production, particularly in Matebeleland South, are predominant. It therefore makes sense to find ways of making rain fed agriculture productive, which will make a contribution to the lives of many people. The presence of irrigated area and water resources for irrigation makes it possible to for the two systems to be complementary. As a matter of fact, many smallholder irrigators do also cultivate rain fed plots and keep livestock.

## 2. Technical Aspects of Irrigation

### 2.1 Irrigation potential

Taking into account available water resources, the irrigation potential of the country is estimated at 365, 000 ha on the basis of the available internal renewable water resources and not water from the Zambezi and Limpopo border rivers and such sources. Water rather land is therefore limiting extent of irrigation –soils classified as irrigable in Zimbabwe are estimated between 600,000 ha.[395][396][397] Estimation of the irrigation potential is based on public dams being managed using a 10% risk factor and 10ML or for one hectare. It has been argued that since a considerable size of the irrigated area is found good rainfall areas and under annual crops the risk factor can be lowered to 20% without much harm to the viability of irrigation.[398]. The Department of Irrigation in the Ministry of Agriculture, Mechanisation and Irrigation Development (MLARR) estimates that with improved efficiencies, reduced security of supply, more use of groundwater and utilisation of transboundary water resources such as Kariba dam and Zambezi water, a total of 2-3 million hectares can be irrigated throughout the country.

### 2.2 Water use in irrigated areas

Irrigation water requirements vary from season to season and are the basis of issuing water permits (Table A8). In smallholder irrigation the 10ML/ha may rise to 12ML/ha because of low irrigation efficiencies.

**Table A8: Indicative irrigation water requirements according to season**

| Season | Irrigation water requirements $m^3$/ha |
|---|---|
| Early summer | 3, 000 |
| Summer supplementary | 4, 500 |
| Winter | 7, 500 |
| Year round | 12, 000 |

Source: FAO (2011)

In the former commercial farming areas sprinkler irrigation was dominant (Figure A6). Use of centre pivots was also growing with 300 centre pivots estimated to have been in place before the fast track land reform programme. Smallholder irrigation is mostly under surface irrigation and is characterized by low irrigation efficiencies of the different system vary (Table A5). In general, much lower irrigation efficiencies, as low as 25 per cent[399] have been recorded in smallholder irrigation because of poor infrastructure and lack of training on the part of farmers and extension workers.

394 Utete, C. 2003. Report of the Presidential land Review Committee. Volume II. Special Studies. Harare, Zimbabwe.
395 Food and Agriculture Organisation (FAO) 2011. Aqustat, Zimbabwe.
396 Food and Agriculture Organisation (FAO). 1995. Irrigation in African in Figures. FAO, Rome, Italy.
397 EuroconsultDelft/Hydraulics Laboratory/Royal Tropical Institute. 1987. Study on options and investment in irrigation development: Country report, Zimbabwe.
398 Makadho, J.M. 1997. An appraisal of the irrigation policy and strategy in view of the evolving water resources management strategy. A paper prepared for the Water Resources Management Strategy, Harare, Zimbabwe.

399Samakande, I. Senzanje, A. and Manzungu, E., 2004. Sustainable water management in smallholder irrigation schemes: understanding the impact of field water management on maize productivity on two irrigation schemes in Zimbabwe. *Physics and Chemistry of the Earth.* 29, 1075-1081.

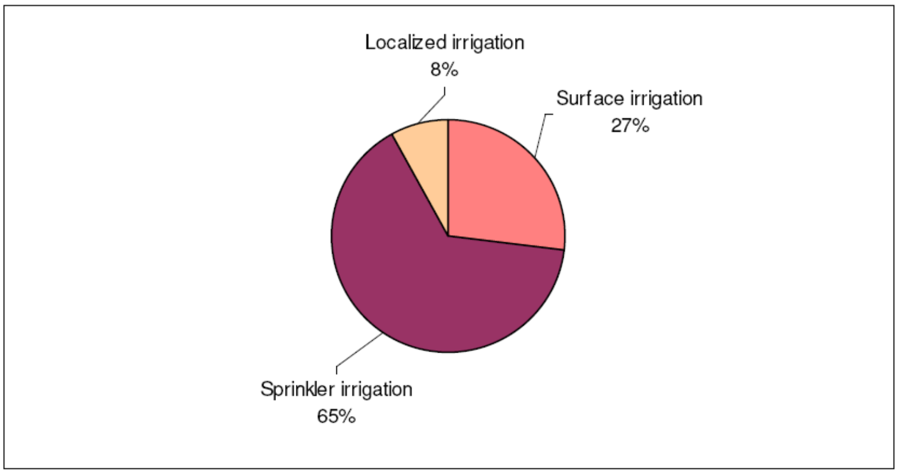


**Figure A6: Irrigated are under different irrigation techniques (Source: FAO, 2011)**

**Table A5: Irrigation water requirements and efficiencies of different irrigation systems**

| Irrigation type | Irrigation water requirements $m^3$/ha | Efficiency (%) |
|---|---|---|
| Surface | 16,000 | 45 |
| Sprinkler | 13,000 | 65-70 |
| Drip | 9,000 | 80-90 |

Source: FAO (2011)

**2.3 Impact of irrigation on crop yields**

Irrigation makes an important contribution to crop production and diversification (see Figure A7). In the commercial sector 100 per cent of the wheat and sugar cane is irrigated, 70 per cent of coffee, 55 per cent of tea and 45 per cent of cotton. In the smallholder farming sector are grown traditional field crops like maize and horticultural crops such as beans, tomatoes and vegetables.

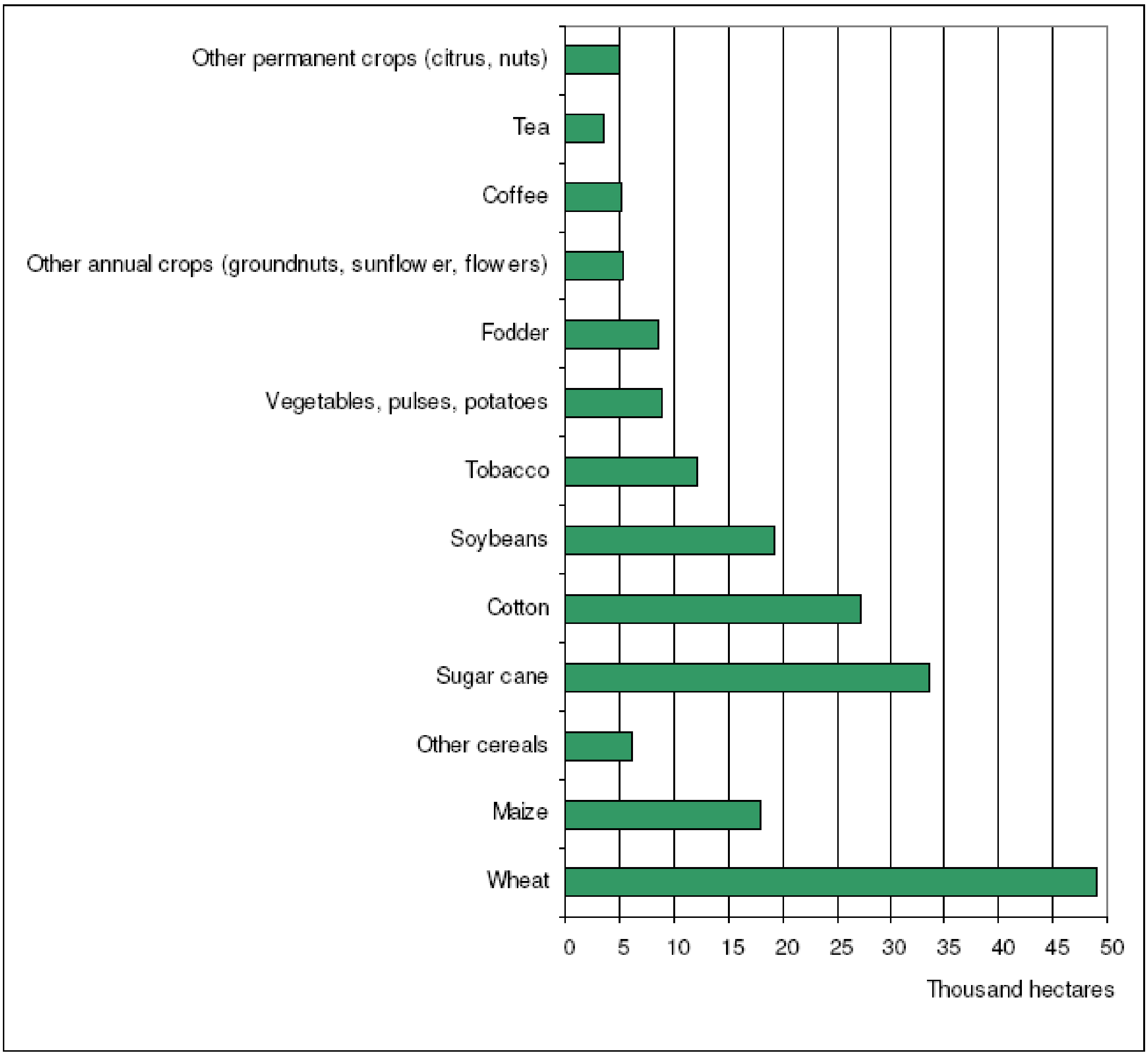


**Figure A7: Crops grown under irrigation in Zimbabwe**
Source: FAO (2011)

### 2.4 Irrigation costs

Financial and viability of irrigation is affected by input factors (development and operation and maintenance costs, cost of rehabilitation, cost of water, energy costs etc) and output factors such as yield level, availability of markets and crop prices. While the cost of irrigation development varies from locality to locality depending on the particular circumstances, there are indicative costs that can be used (Table A6). Not only are irrigation development costs very high, the rehabilitations costs are equally high. Such costs are common in sub-Saharan Africa, and ways and means have to found if irrigation is to be sustainable.[400][401] Coupled to these high costs are agricultural production issues (low crop yields, low crop prices low demand). No wonder the financial viability aspects of many smallholder irrigation schemes has been found to be poor with farmers failing to pay Operation and Maintenance (O&M costs) even when capital costs are treated as sunk costs. Table A9 shows the development and rehabilitation costs of irrigation in Zimbabwe.

The cost of water is subsidized for smallholder irrigation in communal areas (Table A10). This is different in the case of electricity where farmers are charged according to actual usage (Table A11). While there may be a case for thinking that farmers may use water efficiently if they are charged according to usage the practical implementation of such a system is difficult. Metering of the water that is used would have to be introduced,

[400] Lankford, B. 2009. Viewpoint –The right irrigation? Policy directions for agricultural water management in sub-Saharan Africa. *Water Alternatives,* 2(3), 476-480.
[401] Van der Zaag, P. 2010. Viewpoint –Water variability, soil nutrient heterogeinty and market volatility –Why sub-Saharan 's Green Revolution will be location-specific and knowledge-intensive, Water Alternatives, 3(10, 154-160.

which is not just administratively difficult to implement but is also expensive. Farmers should take advantage of the current system and use water more efficiently and thus irrigate more land.

**Table A9: Costs associated with different irrigation systems**

| Irrigation type | Capital costs US$/ha | Rehabilitation costs US$/ha | O&M costs (US$/ha/yr |
|---|---|---|---|
| Surface | 10, 000 | 4, 500 | 375 |
| Sprinkler | 8, 500 | 3, 000 | 500 |
| Drip | 13, 000 | 6, 000 | 250 |
| Average | 10, 500 | 4, 500 | 345 |

Source: FAO (2011)

**Table A10: Cost of water charged to different farmers in Zimbabwe**

| Customer category | Tariff US$/Mega litre (ML) |
|---|---|
| A2 Farmers | 5.00 |
| A1 Farmers | 3.00 |
| Communal Farmers | 2.00 |
| Industry | 9.45 |
| Local Authorities | 6.00 |
| Commercial Agriculture (Estates) | 12.00 |
| Mining | 50.00 |

Source: ZINWA (2016)[402]

**Table A11: Electricity charges for agricultural consumers ($/kwh)**

| Low voltage | 11 KV supply | 33 KV supply |
|---|---|---|
| $0.12 | 0.0-0.12 plus $6.93 monthly fixed charge | $0.05- $0.12 plus $5.08 monthly fixed charge |

Source: Zimbabwe Electricity Transmission and Distribution Company

**3. Social and economic viability of irrigation**

Since their establishment in the mid-1930s by government, there have been many debates as to whether smallholder irrigation in Zimbabwe is financially and economically viable or are social viable in the sense that they provide food security and promote rural development.[403] With the benefit of many studies on the subject, there is no scientific basis to conclude that smallholder irrigation in intrinsically financially and economically unviable. What seems to matter is the technical and social design of the irrigation schemes.

**4. Governance issues**

The relationship between government and smallholder irrigation has been strained because of conflicting viewpoints about the role of irrigation and how it should be operated. In the early stages farmers were basically considered to be incompetent tenants who needed close control by the state**.** The relationship has since evolved to a situation where farmers are recognized as playing an important role in the operation and maintenance of schemes, which saw the introduction of Irrigation Management Committees (IMCs) in the early 1980s. Today the position of government is that farmers can take over all aspects relating to the management of irrigation schemes.

**5. Gender and irrigation**

An analysis of gender dimensions in smallholder irrigation revealed a number of issues, namely:

- Labour and land –irrigated agriculture is important for women but increases their workload and their rights are sometimes precarious.
- Technology–there is no agreement on the type of irrigation technology which is preferred by women

[402] Supplement to the Zimbabwean Government Gazette 6 May 2016, Government Printer, Harare, Statutory Instrument 48 of 2106: Zimbabwe National Water Authority (Raw Water Tariffs) Regulations 216. CAP 20: 25.
[403] Manzungu, E. and van der Zaag, P. 1996. Continuity and controversy in smallholder irrigation'. In: Manzungu, E. and van der Zaag, P. (Eds.) *The Practice of Smallholder Irrigation: Case Studies from Zimbabwe* ,Harare: University of Zimbabwe Publications. ISBN 0978 307 51 9 pp. 1-28.

- Extension – extension tends to focus on cash crops, and while these are important to women, other food crops tend to be ignored, which is not helped by rigid cropping programmes
- Markets -in environment where marketing outlets are few men tend to dominate the formal market while women market their crops through local informal networks which may be less rewarding.
- Management: women and elected to positions in Irrigation Management and the post of treasurer seems to be reserved for women. However, the level of financial literacy may not match the responsibilities[404].

[404] Manzungu, E. and Zaag van der, p. 1996. Continuity is smallholder irrigation. In; Manzungu, E. and Zaag van der, P. (eds.) The practice of smallholder irrigation: Case studies from Zimbabwe, Harare: University of Zimbabwe Publications, 1-28.

## Appendix 8.: Status of weather and climate observing stations and forecasting

Figure A10 shows the geographic distribution of meteorological stations in Zimbabwe.

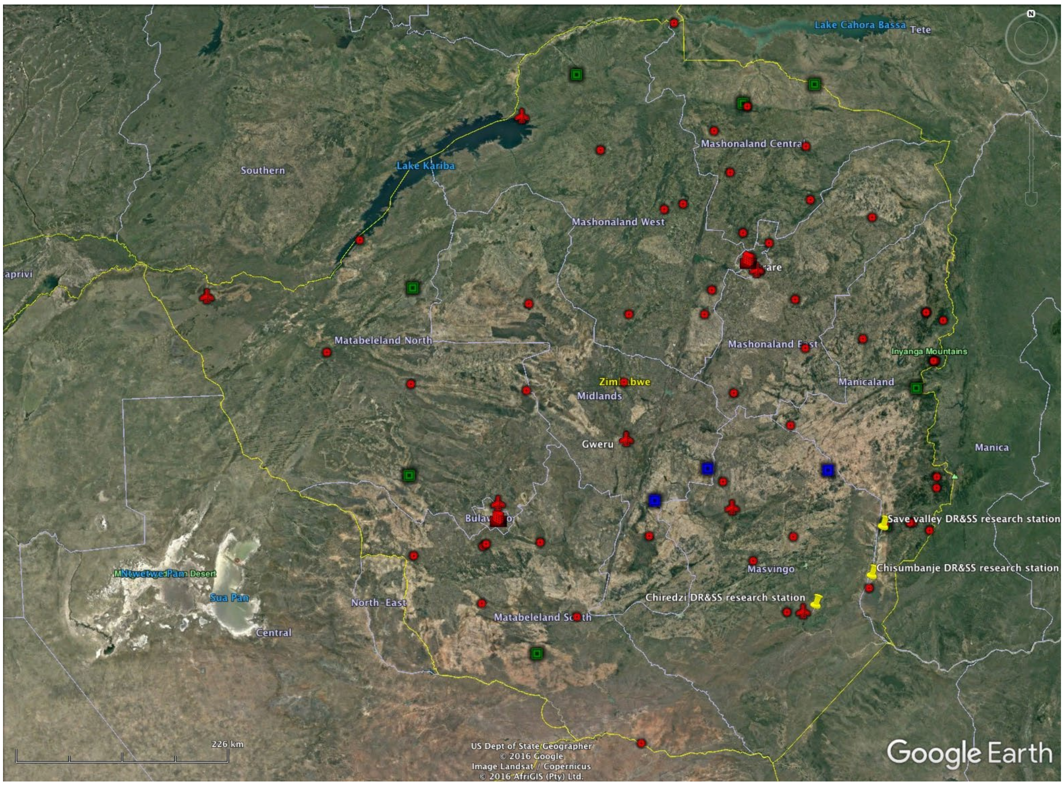


**Figure A10:** Stations in red are manual (airports – airplane, MSD offices – building), green squares are AWS, blue squares AWS through Oxfam UNDP/GEF project, yellow pins AWS at DR&SS research stations (installed by CIMMYT).

Table A14 shows the location and status of existing synoptic, agromet and rainfall (climate) stations in the three catchment areas: Save, Runde and Mzingwane. In this regard, several gaps are noted in the current flow and availability of data, namely:

- Synoptic weather stations collect meteorological data at synoptic times: (GMT+2) 0200hrs, 0500hrs, 0800hrs, 1100hrs, 1300hrs, 1500hrs, 1800hrs, 2000hrs. Data is collected at (GMT) 0600hrs for the 0800hrs (GMT2). There is data loss between 2001hrs to 0159hrs. The weather data are transmitted to the World Meteorological Organisation (WMO) global database. The data is used in the global weather forecast models. Synoptic stations currently include both Automatic and Manual Weather stations
- Agromet stations collect data every day but only transmit the data (by phone) every 10 days
- Rainfall only stations are usually run by volunteers and data collection is done monthly. However, this information is stored at district level as subsidies for sending information were stopped

**Table A14:** Location of MET stations in the Save, Runde and Mzingwane catchments

| District | Station | Type | Gap /Type | Messages Transmission |
|---|---|---|---|---|
| Chipinge | Chipinge (67983)<br>Chisumbanje (?) | Synoptic, Agromet, Climate | Existing AWS is not functioning. AWS Required | Telephone to Main collection Center (Harare) |
| Chimanimani | Chisengu | Synoptic, Agromet, Climate | AWS Required | Telephone to Main collection Center (Harare) |

| | | | | |
|---|---|---|---|---|
| Nyanga | Nyanga (67889). Mukandi (67895). | Synoptic, Agromet, Climate | Ruwangwe/ AWS -Site indentified | Telephone to Main collection Center (Harare) |
| Makoni | Rusape (67881) | Synoptic, Agromet, Climate | | Telephone to Main collection Center (Harare) |
| Buhera | Buhera (67875) | Synoptic, Climate | AWS Required -Site indentified | Telephone to Main collection Center (Harare) |
| Beitbridge | 67991 | Synoptic, Agromet, Climate | Chikwalakwala/ Syn, Agr. Clim | Telephone to Main collection Center (Harare) |
| Insiza | Nil | | Shangane & / Syn, Agr. Clim, Ft Rixon/AWS Silalatshani Irr /AWS | |
| Umzingwane | Nil | | Esigodini Agric/ AWS | |
| Matobo | 67961 (Kezi) | Synoptic, Agromet, Climate | | Telephone to collection Center (Bulawayo Airport) |
| | 67963 (Matopos) | Synoptic, Agromet, Climate | | Telephone to collection Center (Bulawayo Airport) |
| Gwanda | 67969 (WestNic) | Synoptic, Agromet, Climate | | Telephone to collection Center (Bulawayo Airport) |
| | Makwe | AWS (u/s) | | |
| | Guyu | Closed | Guyu /AWS | |
| Bulilima | 67951 (Plumtree) | Synoptic, Agromet, Climate | Maitengwe /AWS, Ndolwane /AWS | Telephone to collection Center (Bulawayo Airport) |
| Mangwe | Nil | | Ingwizi: Synoptic, Agromet, Climate | |
| Masvingo | Makoholi | Climate | - | |
| Masvingo | Rupike | Climate | - | |
| Zaka | Zaka | Climate | - | |
| | Buffalo range | Aviation/ Climate | - | |
| Masvingo | Masvingo airport | Aviation/ Climate | - | |
| Mwenezi | Neshuro growth point (Agritex office) | | - | |

**Automatic weather stations** (AWS) report by sending data automatically from the field to the central servers at HQ (the MSD in Harare), allowing for real time reporting (as opposed to manual reporting stations which send data daily (synoptic stations), or weekly/monthly (for agromet and climate stations). Text files carrying data are sent every hour from the AWS stations via a GPRS modem which requires a SIM card with data bundles. The station uses the data bundles in the SIM card to send data through service providers like Econet, Net One or Telecel. Data is then archived on the central servers' databases and is used by meteorologist to prepare forecasts. Maintenance of the AWS is carried out quarterly every year. MSD is using Climsoft version 4 database for the archiving of AWS data, having recently migrated from Climsoft version 3. MSD has partnered with different stakeholders to install AWS around the country (see Table A15 below).

**Table A15:** Companies that the Department deals with in the provision of AWS'.

| **Company** | **Website** | **Email** | **Contact No** |
|---|---|---|---|
| Vaisala Oyj | www.vaisala.com | sales@vaisala.com | +358(0)989491 |

| | | | |
|---|---|---|---|
| | | metsaleshel@vaisala.com | |
| Sutron | www.sutron.com<br>www.meteostar.com | araval@sutron.com<br>tsoto@sutron.com<br>sales@sutron.com | +3866010075<br>+3864734232 |
| Pulsia IV | www.pulsonic.net | info@pulsonic.com | +33(0)164463410 |
| CimelElectronique | www.cimel.fr | cimel@cimel.fr | +33143487933 |
| Sterela | www.sterela.fr | meteo@sterela.fr | +33 (0)5 62 11 78 78 |
| Adcon Telemetry | www.adcon.at | info@adcon.at | +43224338280-0 |
| Campbell Scientific | www.csafica.co.za | sales@csafrica.co.za | +27 21 880 9960<br>+27 83 266 2246 |

DR&SS research institutions (see Table A16) also collect data for MSD. However, the weather stations are not currently automated. Laboratory facilities need modernisation and internet connectivity is present at each station but suffers from low bandwidth and aging equipment. At Save Valley, Chiredzi and Chisumbanje they have equipment as per Table 3, below. The data collectors are trained by MSD to complete a template and they send data monthly by post. With respect to Makoholi and Matopos, MSD have resident data collectors from MSD, who send the information to their stations directly monthly. At all stations, the MSD provides a backstopping service to make sure the equipment is in good shape. However, there has not been any renewal of the equipment for a long time, though CIMMYT have installed some AWS at the Lowveld stations (not reporting on the national network) because they use them as sites for development of drought tolerant varieties.

**Table A16:** Status of weather instruments: Lowveld research institute: 2017

| Station | Weather instrument | Condition | Remarks |
|---|---|---|---|
| **Chisumbanje Experiment Station** | Evaporation pan (Class A) | Good | Working well |
| | Sunshine recorder | Good | Winter/Summer cards out of stock |
| | Wind vane | Good | Working well |
| | Cup Anemometer | Good | Working well |
| | Standard rain gauge | Good | Working well |
| | Thermometers:<br>Maximum/minimum<br>Wet and Dry bulb | Good | All working well |
| | Automatic rain gauge | Not working | Chock gone for repair |
| | Thermograph | Not working | Chock gone for repair |
| | Automatic Weather Station (Installed by Cimmyt) | Good | Working well |
| **Save Valley Experiment Station** | Evaporation pan (Class A) | Good | Working well |
| | Sunshine recorder | Good | Winter/Summer cards out of stock |
| | Wind vane | Good | Working well |
| | Cup Anemometer | Good | Working well |
| | Standard rain gauge | Good | Working well |
| | Thermometers:<br>Maximum/minimum<br>Dry and wet bulb | Good | Stevenson screen in bad condition.<br><br>Cloth torn |
| | Automatic rain gauge | Good | Chock gone for repair |
| | Thermograph | Not working | Chock gone for repair |
| | Automatic Weather Station (Installed by Cimmyt) | Good | Working well |

| | | | |
|---|---|---|---|
| **Chiredzi Research Station** | 2 X Evaporation pans (class A) | Very Poor | One needs hook gauge and the other leaks |
| | Sunshine recorder | Good | |
| | Wind vane | Good | Working well |
| | Cup Anemometer | Good | Working well |
| | Rain gauge | Good | Working well |
| | **Thermometers:**<br>1. Maximum<br>2. Minimum<br>3. Dry Bulb<br>4. Wet bulb<br>5. Soil Thermometer | Good<br>Good<br>Good<br>Poor<br>Poor | Needs container, bottle working well<br>Soil Thermometer broken |
| | Automatic weather station (Installed by Cimmyt) | Good | Working well |

## Appendix 9.: AGRITEX In-Service Training Courses

**AGRITEX Obligatory In-service Training Courses**

### A. Agricultural Extension Workers

1. Induction
2. Agricultural extension including Extension Methods
3. Public speaking
4. Extension Programme planning incorporating Diagnostic surveys
5. Extension Training (Training of Trainers)
6. Soil and water conservation
7. Farm management
8. Crop production
9. Land use planning
10. Climate change and variability
11. Farming as a business

### B. Agricultural Extension Supervisors

- Extension management for Supervisors

### C. District Agricultural Extension Officers

- Extension management for DAEOs

### D. Officers (Agricultural Extension Officers and Specialists)

1. Induction
2. Agricultural extension including Extension Methods
3. Public speaking
4. Extension Programme planning incorporating Diagnostic surveys
5. Extension Training (Training of Trainers)
6. Conservation 1
7. Conservation 11 and 111
8. Agronomy foundations
9. Land use planning 1
10. Land use planning 11
11. Management course
12. Irrigation A
13. Air photo Interpretation
14. Farm management 1

### E. Senior Officers

1. Extension management for Senior Officers

*Source:* AGRITEX

**AGRITEX Other Inservice Training Courses**

### 1. CROP PRODUCTION

- Apiculture
- Horticulture-
- Agroforestry
- Post Harvest Technology
- Safe use of Pesticides
- Crop Production
- Cotton
- Tobacco

**2. PLANNING**

- Cartography 1
- Cartography 2
- Cartography 3
- GIS

**3. SOIL AND WATER CONSERVATION**

- Soil and water conservation 4
-

**4. TRAINING**

- Writing and Editing
- Audio Visual Aids
- Agro- Home Economics
- Desk Top Publishing

**5. MANAGEMENT SERVICES**

- Farm management 2
- Farm management 3
- Sampling techniques and Data Management in Diagnostic surveys
- Project preparation and planning
- Data Management and analysis

**6. COURSES THAT CAN BE CONDUCTED ON REQUEST**

- Group Dynamics
- Time management
- Farm machinery and tillage
- Package programme design
- Training for Transformation

*Source:* AGRITEX

## Appendix 10.: DR&SS research institutes in HQ and southern regions and their main functions

**DR&SS institutes found at HQ and in the southern regions and their main functions:**

| Department's Divisions | Institute | Major focus |
|---|---|---|
| Division of Livestock and Pastures Research | Makoholi Research Institute | Breeding and conservation of the Mashona cattle breed; small stock research and development of small stock (sheep) for dry areas; rangeland management, forage development including use agro-forestry species |
| | Matopos Research Institute | Crossbreeding of indigenous and exotic breeds; conservation of Tuli, Nguni, and Afrikander cattle breeds, Sabi sheep and Matabele goat; range and pastures research for dry areas; livestock nutrition research; beef cattle productivity studies; small stock productivity studies (except pigs); draught animal power research; smallholder dairy development for dry areas and indigenous poultry research. |
| | **Divisional Headquarters** | Planning, coordination, resource mobilization, monitoring and evaluation of programmes and projects in the Division |
| Division of Crops Research | Agronomy Research Institute | Development of crop **agronomy** systems, including synchronization of **physiological** responses of crops with various crop management strategies such as time of planting; fertilizer and soil fertility management; plant density and integrated weed management systems for various field crops that include cereals, edible & industrial oilseeds, grain legumes, and roots and tubers. |
| | Crop Breeding Institute | Develops varieties, maintains and provides *breeders'* seed of various field crops including cereals (maize, wheat, sorghum, millets and rice); oilseeds (soybean, sunflower and groundnut); pulse legumes (cowpea, bambara nut and bean) and a tuber crop (Irish potato). The breeders' seed supplied to seed companies is used in 'bulking' of *Foundation* and subsequently*, Certified* seed for the market. |
| | Lowveld Research Institute (Composed of Chiredzi, Chisumbanje and Save Valley stations, with Chiredzi being the HQ of the Institute) | Develops, tests and gives advisory information on crop agronomy & horticulture, specifically targeted for **very dry** (semi-arid) environments that are typical of Natural **Region V** of the Lowveld in the country. The institute has two major thrusts: (**a**) developing integrated soil, water and crop nutrition management systems for dry land smallholder crop production and (**b**) development of irrigation-based crop systems that include appropriate micro-irrigation for smallholder gardens and irrigation for commercial crop production in the semi-arid areas. |
| | **Divisional Headquarters** | Planning, coordination, resource mobilization, monitoring and evaluation of programmes and projects in the Division |
| Division of Research Services | Chemistry and Soil Research Institute | Dual functions of carrying out analytical services and performing agricultural research in support of agricultural productivity and production. Its sections include (a) **Crop Nutrition:** Diagnostics of plant nutrition deficiencies and provision of guidelines on lime & fertilizer use to crop producers. (b) **Pedology and Soil Survey:** Conducts soil resources surveys for agricultural development (irrigation or dam construction) and natural resources assessment for national parks and environmental impact assessments to support various projects and (c) **Soil Productivity Research Lab:** Soil productivity studies on different soil types; runs the legume inoculant factory for production of nitrogen bio-fertilizer for use in soybean, groundnut and various other legumes, including forage legumes production. |
| | Fertilizer, Farm feeds and Remedies Institute | Administers the *Fertilizers, Farm Feeds & Remedies Act* (*Chapter 18:12*) and its programmes include: Inspections and analysis for quality management of fertilizers, agricultural lime, livestock feeds and pesticides and other agricultural products |

| | | |
|---|---|---|
| | | for compliance with national and international standards. Does related research. |
| | Genetic Resources and Biotechnology Institute | Charged with national plant genetic resources collection, characterization & conservation, both in cold store (*ex-situ*) for materials that can be stored in seed form and in the field (*in-situ*) for vegetative-propagated materials. |
| | National Herbarium and Botanic Garden | Carries out studies that support identification, classification and preservation of the nation's flora, mainly trees and shrubs. It conducts research in the classification and naming of plants; preservation of the national plant collection for reference and research; provides plant advisory services on plant names, plant identification and plant uses. |
| | Plant Protection Research Institute | Crop protection research and service programmes including coordination of control of scheduled (migratory) pests such as quelea bird, armyworm and red locust. Zimbabwe has an international obligation to control such pests and the institute coordinates their control and management. The institute provides entomology, pathology and nematology services and related advice to clients. |
| | Seed Services Institute (SSI) | Administers the *Plant Breeder's Rights Act* (*Chapter 18:16*) and the *Seed Act* (*Chapter19:13*) and is responsible for seed quality control for both the local and international markets and seed trader licensing. It is accredited to the International Seed Testing Association (ISTA) on laboratory proficiency testing. Does research on seed matters. |
| | Biometrics and Computer Services Institute | An internal service institute that fulfils the Department's ICT requirements. It supports researchers with appropriate selection of experimental designs, data collection guidelines and statistical analysis of research data. It does archiving of the department's experimental data sets for future reference, maintains a database of the Department's projects, and selects and procures computer software and hardware, as well as maintain same. |
| | **Divisional Headquarters** | Planning, coordination, resource mobilization, monitoring and evaluation of programmes and projects in the Division |

*Source:* http://www.drss.gov.zw/

**Overview of research for mitigation and adaptation to climate change in the Department of Research and Specialist Services DR&SS**

- **Development of drought and heat tolerant early maturing varieties** –e.g. (i) Drought tolerant Maize hybrid varieties released by the Crop Breeding Institute over the last 5 years are ZS263, ZS265, ZS269, ZS271, ZS271, ZS273 and ZS275. The pro-vitamin A, orange maize ZS242 is also drought tolerant. This is in addition to the Open Pollinated Varieties, ZM309 and ZM401. (ii) summer wheat varieties due for release (iii) drought tolerant bean varieties
- **Special emphasis on breeding of small grain crops** –(i) sorghum and millets, (ii) – legumes e.g. Bambara groundnut, cowpea and groundnuts in line with government's crop diversification thrust for marginal areas. Some cowpea lines with high drought tolerance are now in the advanced breeding trials.
- **Introduction of new drought tolerant crops and promotion of root and tuber crops** – chick pea, cow pea and bambara nut, cassava, sweet potatoes
- **Research on conservation agriculture** –integrated weed management, reduced tillage, effect of mulch on moisture conservation, water harvesting and moisture conservation techniques, planting dates
- **Research on intercropping** – maize/beans, coffee/banana/beans cropping systems
- **Pastures research** –(i) development of the drought tolerant *Brachiaria bryzantha*, (ii) production of pastures under different manure levels for hay production, (iii) Baling of fine stem stylo as dry season supplement
- **Smallholder dairy research** – (i) forage sorghum for silage production, (ii) crossbreeding indigenous females with exotic breeds to increase hardiness of local dairy breeds
- **Rangeland research** –(i) Feeding urea-treated mopane leaves as high protein supplements (ii) reclamation of degraded rangelands – use of livestock for healing degraded rangelands through confining high populations in a given area e.g. cattle for 7 days; pigs, chicken to loosen the soil and improve water infiltration
- **Conservation and promotion of indigenous breeds –** (i) Cattle **-**Mashona, Nguni, Tuli, (ii) Sheep – Sabi, (iii) Goats -Matebele
- **Modelling crop- livestock interactions under different climate change scenarios**
- **Development of irrigation management practices for various crops**

**Current collaborators**

- Practical Action – Community based seed production of small grains and pulses
- CTDT - Community based seed production of small grains and pulses
- CIAT/PABRA – Upscaling of bean production through community-based seed production, climate resilient agriculture practices, market linkages, promotion of nutrient-dense bean production in collaboration with FNC, AGRITEX
- Palladium -Community-based seed production small grains and pulses
- WWF -CA as a climate smart technology in collaboration with AGRITEX, Department of Mechanisation, ORAP
- SNV/ICRISAT -groundnut value chain
- SNV -Crop livestock interaction: Artificial insemination and forages -forage seed as adaptive measure
- ICRISAT -modelling with Matopos Research Institute -AgMIP
- ICRISAT/ILRI: Forages – forage seed from Matopos Research Institute
- PLAN International – Rangeland reclamation in climate smart villages, Scaling Up Adaptation project
- African Centre for Holistic Management/DEBSHAM: Holistic management
- Fintrac/HIVOS: Breed improvement
- IAEA -mutation breeding of cowpeas: drought tolerant lines identified and to be released soon. Opportunities for farmer variety selection and seed production

## Appendix 11.: Past and on-going interventions in smallholder irrigation in Zimbabwe

| Project/Programme details | Description | Results/current status |
|---|---|---|
| **Name:** Public Sector Investment Programme (PSIP)<br>**Funder:** GoZ<br>**Implementation agency:** DoI<br>**Amount:** USD5.5 million over a five-year period (USD2.5 million spent annually)<br>**Duration:** On-going | Rehabilitation and construction of communal irrigation schemes through DoI in-house design and construction | Since 2000, an area covering 3,500ha rehabilitated since 2000.<br>Training of engineers, technicians and farmers. |
| **Name:** Smallholder Irrigation Support Project<br>**Funder:** EU, FAO and GoZ<br>**Implementation agency:** FAO<br>**Time period:** 2014-2017<br>**Amount:** 6 million Euros<br>**Beneficiaries:** 2,000 households | Rehabilitation of **20 smallholder irrigation schemes (1,000ha)** in **Manicaland and Matebeleland South** provinces.<br>Focus on agribusiness development in smallholder irrigation, providing farmer training on 'farming as a business', enhancing sub-catchment management and conservation, and increasing service delivery capacity of institutions supporting irrigation schemes, e.g. training of engineers, technicians and Extension Officers. | - Increased crop yields: from 1t/ha to at least 5t/ha<br>- Strong market linkages developed involving financiers and buyers of agricultural produce<br>- Foundation laid for a private-sector based extension service management model<br>- However, programme lacked a focus on climate proofed irrigation designs and some projects in Matabeleland South were washed away by floods in early 2017 |
| **Name:** Brazil-Zimbabwe cooperation programme under the More Food for Africa Programme<br>**Funder:** Brazil<br>**Implementing agency:** GOZ<br>**Duration:** MoU between Brazil and Zimbabwe signed in 2011. Second phase is expected to start later in 2016<br>**Amount:** USD270 million (not all budget is earmarked for irrigation).<br>**Beneficiaries:** Approx. 60, 000 households | Agricultural mechanisation cooperation programme supplying tractors, tractor-drawn equipment and irrigation equipment under a concessionary loan agreement. | - Delivery of first of three tranches of tractors, mechanisation and irrigation equipment amounting to USD38 million executed between October 2014 and January 2015. Second phase was planned to start in 2016.<br>- Practically every smallholder irrigation scheme in the country has been availed a tractor and irrigation equipment under a loan arrangement.<br>- Some irrigation schemes have been equipped with modern, more efficient irrigation systems such as centre pivots. |
| **Name:** Rehabilitation of Small Irrigation Schemes in Zimbabwe<br>**Funder:** SDC (Swiss Agency for Development Cooperation)<br>**Implementing agency:** International Water Management Institute (IWMI)<br>**Partners:** GoZ (Dept of Irrigation), CIMMYT, GRM, FAO<br>**Budget:** 8,700,000 Swiss Francs<br>**Duration:** 2 years (Jul 2011 – June 2013)<br>**Beneficiaries:** 2,000 persons | Rehabilitation of irrigation infrastructure and promotion of commercial irrigation in Fuve-Panganai and Rupike schemes, Masvingo province. | - Studies on constraints facing smallholder irrigation were completed with marketing challenges being the most outstanding<br>- Irrigation infrastructure rehabilitated but costs of rehabilitation too high because of use of huge fees charged by IWM, underlining the need to use local organisations as implementing agencies<br>- Farmers trained in all aspects of scheme management |
| **Name:** Rehabilitation of Small Irrigation Schemes (Phase II of project, above)<br>**Funder:** SDC<br>**Implementing agency:** FAO and GOZ<br>**Duration:** Dec 2014 – Dec 2018<br>**Amount:** CHF 6,080,000<br>**Beneficiaries:** Up to 200 in 8 irrigation schemes covering 700 ha | Rehabilitation of small-scale irrigation schemes in Masvingo province and linking them to viable markets. | - Programme is underway and is yet to reach its mid-point, therefore too early to measure results<br>- Early indications show that the programme is progressing well |

| Project/Programme details | Description | Results/current status |
|---|---|---|
| **Name:** Nyakomba Irrigation Scheme expansion<br>**Funder:** Japan International Cooperation Agency (JICA)<br>**Amount:** USD15 million<br>**Duration:** Dec 2016 - March 2019<br>**Beneficiaries:** 230 farmers added (861 smallholder farmers in total). | Rehabilitation and construction of a new block (146ha) at Nyakomba irrigation scheme (re-started after blocks B, C and D were completed in 2000). | Just started. |
| **Name:** Munjanganja Irrigation Scheme<br>**Funder:** JICA and GOZ<br>**Amount:** Unavailable<br>**Duration:** Unavailable<br>**Beneficiaries**: 175 plotholders | Construction of Munjanganja Dam and infield infrastructure, managed by an IMC that has a binding constitution. Supported by DoI in maintenance and AGRITEX in agronomy. | Irrigators confirmed that they rely more on the irrigation enterprise than on rainfed crops because they have high yields all year with a good harvest when water is available. However, the neighbourhood market is about 30 km away – there is a need to create market linkage for farmers[405]. |
| **Name:** Smallholder Irrigation Revitalization Programme<br>**Funder:** International Fund for Agriculture Development (IFAD)<br>Implementing agency: GoZ<br>**Total project cost:** US$ 51.2 million<br>**DSF grant:** US$ 25.5 million (channelled through Ministry of Finance) **Approval date:** 2016-09-22.<br>**Number of beneficiaries**: 20, 000 households | Revitalization of 8,000 ha of existing smallholder irrigation schemes, mostly in communal and old resettlement areas in Manicaland, Masvingo, Matabeleland South, and Midlands provinces, through: 1) rehabilitation and development of irrigation infrastructure, 2) extension of agricultural credit, 3) institutional strengthening, 4) improving market access and business development and 5) ensuring adequate catchment management. GoZ is expected to establish a unit to co-ordinate the implementation of the programme. | Due to start in April 2017. The Programme will disburse some of the money through DoI. To this end, the Department has been audited by Deloitte and Touche. |
| **Name:** Shashe Irrigation scheme<br>**Donor:** EU, UNDP/GEF<br>**Implementing partners:** CESVI and Safire<br>**Amount:** Unavailable<br>**Safire grant:** 1.5 million<br>**Duration:** 2011-2015 | Introduced highly valuable long-term (citrus) and seasonal (grains and vegetables) crops through strategic partnerships (Schweppes) and sustainable modern irrigation technology (submersible pumps and centre pivots). | - Model concluded viable to be up-scaled (with slight modifications necessary for fit for purpose)[406] |
| **Name:** Climate Resilient Infrastructure Development Facility (CRIDF) pilot projects: Kufundada and Bindamombe<br>**Funder:** DFID<br>**Duration:** 2013-2016<br>**Amount:** £24 million | Construction of (new) climate resilient infrastructure through a river basin approach, underpinned by a 100kW renewable energy power source (solar) and based on a financial and economic assessments. Facilitated IMC formation and constitution drafting (including a 'maintenance fund'); introduced offtake purchase agreements and an out grower market linkage; integrated AGRITEX into the running of the scheme; facilitated soil fertility restoration on degraded lands. | Solar power to hospital<br>Functioning IMC with Maintenance Fund<br>Successful communally owned and managed bulk irrigation infrastructure |
| **Solar interventions on irrigation schemes** | | |
| **Name:** Mashaba Solar Mini Grid Funders: European Union (EU-ACP), OPEC Fund for International Development (OFID), the Global Environmental Facility (GEF)<br>**Implementing agencies:** SNV, Practical Action, and Dabane Trust with the support of Government Ministries and Departments. | Solar energy provided to three irrigation schemes, five business centres, a clinic, a school and a study centre in Gwanda south. The project demonstrates a business and financial model of providing decentralised renewable energy through a partnership of public and private sectors and donors. | - A 99KW decentralised mini-grid, 2 energy centres and 2 stand-alone power units that will sell power to 3 irrigation schemes, 5 business centres, a clinic, a school and a study centre[407]. |

405 OECD. 2012. Effective support for agricultural development. China-DAC Study Group.
406 Latham, C. J. K. et al. 2015. From Subsistence Agriculture to Commercial Enterprise: Community management of green technologies for resilient food production. Future of Food: Journal on Food, Agriculture and Society. 3(2), pp. 8-17.
407 SNV. 2017. Sustainable Energy: Rural Communities: Mashaba Solar Mini Grid. Available on: http://www.snv.org/project/sustainable-energy-rural-communitiesmashaba-solar-mini-grid (Accessed 5 May 2017)

| Project/Programme details | Description | Results/current status |
|---|---|---|
| **Duration:** 2015-2019<br>**Amount:** £4.6 million<br>Beneficiries:10, 000 persons | | |
| **Name:** OXFAM Rural Sustainable Energy Development (RUSED)<br>**Funders:** cofounded by the European Union through the ACP-Energy facility and Oxfam<br>**Implementing agencies:** jointly implemented by Oxfam and Practical Action.<br>**Amount:** EURO 2 million<br>**Duration:** 4 years (August 2011 – July 2015)<br>**Beneficiaries:** 19,200<br>**Target groups:** 300 irrigation farming households, 2 clinics, 1 school, 20 local entrepreneurs and 1 agribusiness centre | Access to modern, affordable, and sustainable renewable energy services in the Gutu and Mutare districts.<br>In Gutu the project expanded the previous project in the district, the Ruti irrigation scheme (from 40 to 60ha for 270 smallholder farmers) | Ruti irrigation project is currently seeing farmers produce an average of 4 to 5 tons of maize per hectare, whereas on their dryland plots they have harvested almost nothing this year (2015) due to serious drought.<br>Creation of a solar market<br>Power to four clinics and two schools |

*Source: Various*

### Appendix 12.: Past and on-going interventions in Zimbabwe with a focus on agriculture production, market linkages and access to finance

| On-going interventions | | |
|---|---|---|
| Programme/project details | Description | Key results |
| Zimbabwe Resilience Building Fund (ZRBF)<br>Donor: Financed by EU, DFID, SIDA, UNDP<br>Implementing partner: MLARR, with the PMU and administration of fund resources supported through UNDP.<br>Duration: 2015-2020<br>Budget: USD 70 million. | The ZRBF programme seeks to address the increasing vulnerabilities of rural communities in Zimbabwe – both due to continued economic and social crisis and the current and projected climate change risks.<br>The resilience approach focuses on the how to manage natural resources efficiently and sustainably in the face of disturbances and uncertainty.<br>The ZRBF programme prioritizes 21 vulnerable districts, targeting 800,000 people over the full programme period. Under the call for proposals in 2016, 3 projects are being implemented in 9 districts, incl. Mwenezi, Umzingwane and Chiredzi, targeting a total of 86595 households. | The ZRBF has produced maps of hazards and vulnerabilities in the country, which have been used for targeting ZRBF and UNDP interventions.<br>All interventions carried out by consortia aim to increase capacities of communities to withstand shocks and stresses.<br>Annual review of consortia interventions were positive, among other things the WHH MELANA intervention reinforced the business case for introducing the climate smart sesame crop to small holders. |
| Name: Scaling Up Adaptation<br>Donor: UNDP/GEF<br>Implementing agencies: Oxfam, Safire, Plan international<br>Duration: 2015-2018<br>Amount: USD 16.68 million including co-funding | A clear focus of this project is to climate proof agricultural livelihoods for smallholder farmers, develop agricultural value chains in a climate smart way and increase smallholders' access to inclusive financial services with a target group of 10,000 vulnerable smallholder farmers in Chiredzi, Chimanimani and Buhera. Also, the project aims to increase knowledge and understanding of climate variability and change-induced risks – through climate information services for agriculture and DRM targeted smallholder farmers. | Mid-term review conducted, with positive evaluation of results. Namely the holistic investments around climate smart villages was highlighted, as was the success of a watershed approach. Other successful experiences included the establishment of 102 VSLA groups, which successfully contributed to increased savings and access to loans for vulnerable communities – as well as facilitation of market linkages for several climate smart value chains, which increased farmers' incomes significantly. |
| Name: Livelihoods and Food Security Programme<br>Donor: DFID<br>Implementing agency: FAO, GRM International and Coffey. LFSP is partnering with local organisations to implement a variety of projects aimed at achieving LFSP's goals, incl. WHH and Care.<br>Duration: 2014-2018<br>Amount: $72 million | The project aims to improve the livelihoods and reduce food insecurity for 350,000 people by targeting 127,000 smallholder farmers in 8 rural districts in Zimbabwe, incl. Mutare. The project introduces improved, climate appropriate agricultural practices, stimulates demand and supply of affordable nutritious foods, links farmer groups to input providers and buyer markets, and facilitates access to rural finance. The project uses Internal Savings and Lending Associations (ISLAs) to empower women. | A number of studies have been conducted to inform the design of interventions. This includes the baseline, a study on climate-smart options for smallholder farmers, a study on market linkages for smallholders among others, which have also informed this feasibility study.<br>It is yet to early to report on the achievements of the project. |
| Name: Stepping Up Resilience and Enterprise (ENSURE)<br>Donor: USAID Food for Peace | The ENSURE Food Security Program, World Vision-led and USAID-funded, targets 215,000 vulnerable and food-insecure Zimbabweans in Manicaland and Masvingo Provinces. Main components of the intervention are | In 2016 ENSURE reported that producer groups enhanced community assets (e.g. dams, irrigation schemes, wells and gardens) and value chains.<br>Lessons learned include the need |

| | | |
|---|---|---|
| Implementing agencies: World Vision Zimbabwe, CARE, SNV, Safire and ICRISAT<br>Duration: 2013-2018 | agriculture for food and nutrition security, economic empowerment and risk management and community resilience.<br>World Vision is the lead implementing partner in Buhera, Chipinge and Chimanimani Districts of Manicaland Province. CARE serves as lead implementing partner in Bikita, Chivi and Zaka Districts of Masvingo Province. | to link farmers to finance.<br>Marketing has to be the core - and CRA interventions benefit from being based on diversification of crops and high value commercial crop to build resilience. |
| Name: Amalima<br>Donor: USAID DFAP<br>Implementing agency: A consortium consisting of Organization of Rural Associations for Progress (ORAP), Dabane Water Works, International Medical Corps, the Manoff Group, and Africare<br>Duration: 2013-2018 | The project provides support to over 56,000 households in Tsholotsho, Bulilima, Gwanda and Mangwe districts. The project promotes conservation agriculture practices and drought resistant crops, engages vulnerable households in productive value chains and utilizes matching grants to help producer groups scale-up production. This includes promotion village savings and loans groups and business management and technical training to agrodealers to improve the availability of and access to quality inputs to farmers. Particular focus on women. | Results have not yet been shared, but key lessons learned include that marketing has to be at the core of interventions. CRA interventions benefit from being based on diversification of crops and high value commercial crop to build resilience. |
| Name: Feed the Future Zimbabwe Livestock Development<br>Donors: USAID<br>Implementing agency: FINTRAC<br>Duration: 2015-2020 | Feed the Future aims to increase incomes and food security for 3,000 beef and 2,000 dairy smallholder producers. FTF trains farmers on good business practices and marketing: identifying lucrative markets within their reach, organizing themselves into groups, and negotiating with buyers for better prices. The program targets smallholder farmers in Manicaland, Midlands, Matabeleland North and South, incl the districts Chimanimani, Chipinge, Chiredzi, Insiza, Masvingo and Umzingwane. | To date, 3,593 rural households have benefited from program interventions. With increased access to banks, markets and training, beef and dairy farmers are entering into productive and sustainable investments.<br>Each beneficiary household will own at least 15-20 beef cattle by the close of the program, and the program will link farmers to local milk processors to facilitate formal sales. |
| Name: Vuna, the Climate-smart Agriculture Programme for East & Southern Africa<br>Donor: DFID<br>Amount: £18 million<br>Duration: 2016 | Across the Southern Africa region, Vuna is piloting innovative delivery mechanisms that encourage the inclusion of CRA in education, adoption of climate-smart agriculture practices and drought tolerant crop varieties, climate risk management into business models of agribusinesses' supply chains and supporting access to climate adaptation finance for farmers as well as governments. | Programme in starting phase. Results have not yet been shared, but a key focus of Vuna is to strengthen the evidence base around climate resilient agriculture (CRA), and the use of this evidence. The program experiences may be relevant to draw on in the future. |
| Name: Smallholder Irrigation Revitalization Programme<br>Donor: IFAD<br>Lead agencies: AGRITEX and DOI<br>Duration: 2016-2023 | The project will be implemented in 16 Districts in 4 Provinces - Manicaland, Masvingo, Midlands and Matabeleland South - with a focus on supporting smallholder agriculture through rehabilitation of irrigation schemes, training in business skill and market | Programme in starting phase. Results have not yet been shared. |

| | | |
|---|---|---|
| Budget: US$ 51.27 million | linkages and capacity building of extension services. The project targets a total of 127000 people and 500 extension and technical service providers. | |
| Name: Smallholder Horticulture and Empowerment Promotion (SHEP)<br>Donor: JICA<br>Implementing Partner: AGRITEX<br>Duration: 2014- | SHEP is an innovative development approach being implemented by JICA in 23 countries in Africa. In Zimbabwe, the project is implemented in Mashonaland East and Mashonaland Central. The approach focuses on promoting farming as a business and linking farmers and market actors directly. | So far, the approach of linking farmers directly to markets and buyers has empowered farmers to negotiate with business actors, has increased their incomes and improved working relationship among extension agents, private sector and farmers. |
| Past interventions | | |
| Programme/project details | Description | Results/current status |
| Name: Coping With Drought<br>Implementing agency: UNDP<br>Donor: GEF<br>Duration: 2008-2012<br>Funding:<br>983,000 USD | The *Coping with Drought and Climate Change Project* aimed to demonstrate and promote adoption of a range of gender sensitive approaches for adaptation to climate change among rural agricultural communities in vulnerable areas of Chiredzi District as a national model for climate change adaptation. | The project piloted a range of adaptation measures that effectively reduced vulnerability to drought in Chiredzi District. The project successfully made use of FFS and research collaborations with a focus on crop diversification, soil moisture management, irrigation systems, livestock enhancement and community based NRM. These experiences were used to contribute the development of a national climate change response strategy and policy – as well as fed into the development of the SCCA project to scale up the interventions. |
| Name: Agro Initiative Zimbabwe (AIZ)<br>Donor: DFID<br>Implementing agency: TechnoServe<br>Duration: 2011-2014, with extension phase with focus on gender equity to 2016 | The project aimed to develop the agro-processing and agriculture sectors by supporting innovative medium-sized agribusinesses that are committed to integrating smallholder farms in their supply chain. Target set to work with 40% women-led businesses and women smallholder farmers by 2016. | Businesses received tailored technical assistance to integrate smallholders into contract farming arrangements. The project demonstrated small-scale farmer capacity to produce top-quality horticulture for international markets, e.g. chilies for the US market. In terms of economic opportunities for women, the program successfully exceeded the project's 40 percent gender target. |
| Name: Zimbabwe Agricultural Income and Employment Development (Zim-AIED)<br>Donor: USAID<br>Duration: 2012-2015 | The focus of the project was to increase incomes and food security of agricultural producers and to generate more income and rural employment of rural agro-business through increased agricultural production, productivity, agro-processing and investment. The project provided technical assistance to improve income food security and income for 150,000 households in Mashonaland Central, Mashonaland | Status: Finalized.<br>Results: Final evaluation Lessons learned from ZIM-AEID include the success and importance of promoting farming as a business. Market understanding and links has to be the core and communities should be encouraged to work together to be able to bring sufficient amounts of goods to market / buyers collectively. |

| | | |
|---|---|---|
| | West, Mashonaland East, Midlands and Masvingo. | |
| Name: Rural Agriculture Revitalisation – Commercialisation of Smallholder Farming Project (RARP-CSF)<br>Donor: DANIDA<br>Implementing agency: SNV<br>Duration: 2010-2015 | The project aimed to contribute to sustainable food security, incomes and employment creation for 280,000 commercially oriented smallholder farmers across Zimbabwe's eight rural provinces. Main components included re-establishment of sustainable commercial marketing channels, technical development services and business development e.g. through win-win sustainable contract farming arrangements and provision of effective business development services [408]. | The project succeeded in facilitating contacts between farmers and a network of 1,200 agro dealers across Zimbabwe. The Zimbabwe Agricultural Development Trust (ZADT) and its CREATE Fund, which started off as a value chain financing component in 2010, now works as a fully-fledged institution. 34 agri-business SMEs have been linked to funding facilities. The project pioneered the development of the sesame and groundnuts value chains – with a focus on improving small-holder farmers' resilience to shocks. |
| Name: The Climate Resilient Infrastructure Development Facility (CRIDF) initiative,<br>Donor: DFID<br>Duration: 2017- | CRIDF supports projects and initiatives across the SADC region with a focus on climate proofing water infrastructure and resource management with a focus to better enable people – particularly the poor – to predict, manage, or mitigate the impacts of extreme climate events on infrastructure. | In Zimbabwe CRIDF has supported the construction of climate resilient irrigation infrastructure in Chivi and Bikita, water planning in Zimbabwe and transboundary water management. |
| Research institutions | | |
| Institution | Description of work | Results/current status |
| The International Crop Research Institute for the Semi-Arid Tropics – ICRISAT<br>Donors: Various<br>Various projects | ICRISAT is part of the global CGIAR research network working for a food secure future. ICRISAT in Zimbabwe has worked towards climate resilience in crops and livestock value chains over the years including small grains, goat and cattle value chains. Also, ICRISAT has worked on agricultural scenario planning in relation to climate change – and has facilitated Innovation Platforms related to the above mentioned value chains. | ICRISAT brings significant research and practice experience on climate-smart crops and varieties, in particular small grains; drought tolerant breeds in the livestock value chain; climate-smart agriculture practices for crop-livestock integration and facilitation of market systems and linkages through market infrastructure and Innovation Platforms. |
| The International Maize and Wheat Improvement Center - CIMMYT<br>Donors: Various<br>Various projects | CIMMYT is part of the global CGIAR research network working for a food secure future. CIMMYT in Zimbabwe is based in Harare. CIMMYT is about to finalize an eight-year food security program supported by the Australian Centre for International Agricultural Research (ACIAR) in several Southern and Eastern African countries (not including Zimbabwe) and is envisioning that the successor project – SIDICRA - could also include Zimbabwe. | Over the years CIMMYT has carried out several successful interventions to breed and promote drought tolerant varieties of maize and wheat in Zimbabwe – including capacity building interventions such as FFS and demonstration platforms as well as support to market linkages through Innovation Platforms. |

[408] SNV. 2017. Rural Agriculture Revitalisation Programme: Commercialising Farming. Available on: http://www.snv.org/project/rural-agriculture-revitalisation-programme-commercialising-farming-rarp-csf (Accessed 5 May 2017)

| | | |
|---|---|---|
| CIAT-PABRA bean production support initiative<br>Duration: April 2015 - March 2019.<br>Funded by: Swiss Agency for Development and Cooperation (SDC) and CIDA<br>Implemented by the International Centre for Tropical Agriculture (CIAT) and the Pan Africa Bean Research Alliance (PABRA). | The Pan-Africa Bean Research Alliance (PABRA) encompasses 3 regional bean research networks, covering 29 countries, which are working to improve the livelihoods of small scale bean farmers in sub-Saharan Africa. In Zimbabwe PABRA is facilitated by the International Center for Tropical Agriculture (CIAT). The goal of PABRA is to enhance the food security, income and health of resource-poor farmers in Africa through research and development of the bean sector. | 2 Innovation Platforms for technology adoption established with results in improved yields and incomes for small holder farmers<br>A total of 67 bean demonstrations were established and improved bean varieties were successfully promoted through field days, agricultural shows and trade fairs. |

Source: *Various*

## Appendix 13.: Past and on-going projects relating to climate information in target river basins

| Project/Programme | Description | Key results |
|---|---|---|
| Coping with Drought and Climate Change in Zimbabwe Project UNDP/GEF (2008-2012) | Explored how climate information could be accessed by farmers through the provision of rainfall gauges at a local level and how extension workers and farmers are capacitated to use them and the information so derived. | • Demonstrated the value of providing rainfall gauges to farmers to monitor their own rainfall.<br>• Successfully developed and prototyped new seasonal forecast approach which was shown to be more useful for agricultural decision making. |
| Mainstreaming Climate Change Adaptation in Zimbabwe's Agricultural Extension System[409], Practical Action (2011-2013) | Aimed at integrating climate change adaptation into the national extension department of AGRITEX. The project trained 60 national and provincial specialists as trainers for 170 district level staff. | Demonstrated the potential of a training of trainers (ToT) approach for scaling out knowledge of adaptation strategies and training to farmers |
| Mainstreaming Climate Change Adaptation in Zimbabwe's Agricultural Extension Services, Practical Action, funded by Nuffield Foundation (2013 – 2014)[410] | Focused on training climate change adaptation to Agricultural Extension Workers (AEWs) in Shurugwi, Umzingwane and Chivi Districts to improve the capabilities of smallholder farmers to cope with and adapt to climate change and variability. 45 Agricultural Extension Workers were trained. | • Significant impact on AGRITEX staff-a core group of practitioners trained -224 prov & dist officers vs. a target of 170, 1,023 AEWs vs. 1560 AEWs in 3 pilot provinces<br>• Engaging farmers to understand the presence and effects of CC appears to be a successful entry point to influencing farmer practices. Over 6,000 smallholder farmers trained by trained AEWs and some farmer groups developed plans to reduce exposure to risks and vulnerability to CC<br>• PICSA approach requires engaging farmers before the rainfall season to discuss available options/strategies and then using those available options to later discuss option based on the seasonal forecast. |
| Strengthening Weather and Climate Change Information Dissemination Systems (SWCCIDS) in Zimbabwe. Oxfam funded under the Leverage and Resource Scarcity Challenge Fund (LRSCF, 2012-2015) | The pilot project targeted three districts, namely Gutu, Chirimhanzu and Zvishavane. The project activities included installation of both manual (15) and automatic weather (3) equipment in 3 targeted districts, training on statistical analysis of weather data for AGRITEX specialists, training on communicating weather and climate information for AGRITEX field staff | Major challenges include:<br>• replacing broken sensors when MSD do not have equipment in stock.<br>• Taking readings during school holidays was neglected as students work with teachers during the school term to take the readings and not whilst on holiday. Extension staff have been responsible for taking readings |

[409] Practical Action. 2012. Mainstreaming Climate Change Adaptation in Zimbabwe's Agricultural Extension System Annual Report 2011/12. Harare. Available on: http://practicalaction.org/nuffield-project (Accessed 5 May 2017)
[410] Practical Action, AGRITEX and University of Reading. 2014. Mainstreaming Climate Change Adaptation in Zimbabwe's Agricultural Extension Services. Final Project Report. Practical Action.

| | | |
|---|---|---|
| | as well as the training of farmers on weather and climate change. MSD are responsible for AWS maintenance. Manual Stations are being manned by AGRITEX extension and school teachers (most installed at schools). Smallholder farmers received agro-meteorological information at regular intervals (every 3 days during winter and 10 days during summer season) through their mobile phones. Farmers were given fire danger warnings and advised to not start uncontrolled fires to protect the environment from veld fires. As not every farmer in the targeted district received the information via their mobile phones, they were encouraged to share with other farmers, as well as establish weather and climate clubs.<br>Bulk messages on weather and agro-met information were pushed to farmers and stakeholders including agricultural extension workers. A private service provider (Esoko) with a suitable product was engaged and distributed information to 600+ farmer representatives. To compliment the ICT platform, the project also used existent community structures including area farmer committees, livestock committees, garden committees and lead farmers to disseminate information. | during school holidays, but data collection has often been erratic, especially if the extension officer is not available on a daily basis to take the reading.<br>Important lessons included:<br>• The partnership created between Oxfam, ZMSD and AGRITEX increased the visibility of MSD in the targeted communities. The department engaged/interacted with the farmers, got feedback and the kind of weather and climate information farmers value, rather than simply giving weather updates on electronic media (radios and television sets) which MSD expected to be useful.<br>• Opportunities for collaborative research with academic institutions were identified and Chinhoyi University of Technology were engaged to take the lead on the research component of the project.<br>• Opportunities to spread other information e.g. on fire risk, as well as the need to identify lead farmers, area farmer committees, livestock committees etc who help spread the weather/climate related information to other farmers who do not have access to SMS/mobile. |
| Scaling up Adaptation in Zimbabwe with a focus on Rural Livelihoods UNDP/GEF (2015 - 2018) | Oxfam and UNDP are working with young innovators from the University of Zimbabwe and the Harare Institute of Technology with technical support from Digital Velocity, an IT company, to come up with innovative solutions that will enhance the delivery and use of tailored weather and climate services in climate risk management among smallholder farmers in Buhera, Chiredzi and Chimanimani Districts. AGRITEX staff were trained on how to take daily readings of temp, humidity, and rainfall during the capacity building training with MSD from the manual weather stations, together with school teachers responsible for Agriculture/Geography in schools | One component of the project focuses on diversified and strengthened livelihoods, whilst a second component focusses on increasing knowledge of climate variability and climate change induced risks. The second component comprises the following key actions:<br>• Establishing Climate User Interface Platforms for smallholder farmers to participate in co-designing, co-producing and using tailored climate products. Eleven (11) young undergraduate innovators from both the Harare Institute of Technology (HIT) and the University of Zimbabwe (UZ) developed innovative climate services solutions in close collaboration with the Meteorological Services Department (MSD), |

| | | |
|---|---|---|
| | where the manual weather stations were installed, as well as with a group of select lead farmers in some areas. | the Department of Agricultural, Technical and Extension Services (Agritex) and the affected farmers<br>• Addressing local level meteorological observations and database management gaps. Installation of rain gauges in each ward and 3 AWS in each district. The flow of data from weather stations to MSD and return forecast data has been analysed and improvements suggested.<br>• Designing and developing tailored weather and climate products for smallholder farmers. New downscaled products using a regional climate model have been developed.<br>• Developing tools for translating climate products into actionable advisories and early warnings<br>• Designing, developing and rolling out a climate information delivery system appropriate to smallholder farmers. Investigations show that SMS via lead farmers is a viable and cost-effective way of disseminating information |
| Integrated climate risk management for food security and livelihoods in Zimbabwe focusing on Masvingo and Rushinga Districts WFP/GCF 2019 | Focus on strengthening capacity for national and community adaptation and management of climate risks based on climate forecasts and information.<br>In addition, the project focuses on increasing the adaptive capacity of food insecure households and enhancing the investment capacity of small-holder farmers to sustain climate-resilient development gains . | The below components of the project relates to climate information systems:<br>- Strengthen national capacity and systems to generate, interpret, deliver tailored climate and weather data and effectively prepare for and manage climate shocks<br>- Strengthen access to reliable climate and weather information by vulnerable communities to support improved decision making for food security and livelihoods<br>- Risk transfer through the provision of weather index insurance (WII) |

*Source*: Various

## Appendix 14.: CRIDF technical assistance to national and regional water authorities

Building on its provision of infrastructure and assistance to better land management, CRIDF has started working with the Mozambique and Zimbabwean Water authorities to build their capacity to promote better land management, scale up appropriate infrastructure for communities, as well as operate existing large scale infrastructure more efficiently. CRIDF's 12 workshops (to date) on local water management for transboundary benefits, climate change mitigation and adaptation and integrated water resource management have been well received by ARA-Centro in Mozambique and its counterpart in Zimbabwe, the Zimbabwean National Water Authority, ZINWA.

The training sessions, delivered to technical staff at the Save and Runde Catchment Offices, as well as other relevant stakeholders from the water authorities, have been successful in building institutional capacity in water management; as well as encouraged a stronger sense of waterway ownership, driving the sustainability of the project. CRIDF's technical assistance has also involved the establishment of a Save Basin Stakeholder Committee in Mozambique, to formalise stakeholder involvement in integrated water resource management and the transboundary joint management of the river basin. This has contributed to formalising partnerships and facilitating communication.

*Promoting regional dialogue and cooperation*
The Save Basin is one of three river basins that traverse the border between Mozambique and Zimbabwe. This cross-boundary location has presented challenges for water resource management and development. Yet CRIDF's intervention in the Save Basin has created a space for dialogue and cooperation. Hosting study tours has facilitated the exchange of information between ZINWA and ARA-Centro, helping to forge better mutual understanding of their respective roles. Both have now implemented and been trained in the utilisation of the same water resource planning and management computer modelling software, viz WRYM & P - Water Resources Yield Model and Planning software. The system enables a more efficient monitoring of water movement by predicting the impact of precipitation changes. Both parties have also agreed to adhere to the Save Joint Water Commission's Save Dam Operation Rules Framework, which mitigates water allocation issues by providing guidance on the optimal operation of large river infrastructure for managing water resources and promoting climate change resilience. The framework has also helped to significantly improve data collection and water resource assessments. For example, the data series for rainfall and information on water resource assessments have been extended by 58 years (now covering 1921 to 2015) as a result. Gathering accurate data has boosted confidence in forecasting and led to better-informed resource allocation.

The CRIDF-facilitated cooperation in the Save has led to three agreements between Mozambique and Zimbabwe including:

- The computer modelling package to support water resource assessment planning, development and management in the basin.
- The pilot dam operating rules which have resulted in the regular sharing of information on the status of water resources between the two countries.
- The joint planning, management and development of the shared Save, Buzi and Pungwe Basins by the Joint Water Commission. This includes joint prioritisation and possible joint implementation of the US$ 1.5 billion dam investment program

CRIDF's initiatives in the Save Basin are resulting in transboundary cooperation and promoting an Integrated Water Resource Management (IWRM) approach. By constructing innovative infrastructure on the ground, CRIDF has succeeded in engaging both ARA-Centro and ZINWA on strategic policy issues that affect the whole basin, and reinforced communication channels between them. CRIDF's approach to trans-boundary water management has positively influenced both countries' attitudes to water governance. Strengthening the relationship between Mozambican and Zimbabwean counterparts is a significant step towards further developing the basin for the benefit of its poorer inhabitants and creating climate change resilience.

## Appendix 15.: Overview of ZimNat weather index insurance

ZimNat has been providing weather index insurance (WII) to farmers for the last 3 years. The WII product is called Pundutso and is available for the 2016-2017 season. The product is the result of 3 years of trialling and research into other models that have been successfully used in Africa. A summary of the cover is provided below:

- Rainfall data is collected from the African Rainfall Climatology (ARC2) database, which is used for claims assessments[411]. This dataset is a combination of satellite and weather station-based measurements. Actual ground weather stations will be identified before the season and shall be used only for verification;
- For the 2016-17 agricultural season, Zimnat Lion will only be concentrating on the input cover only. Yield cover will be considered on a case by case basis;
- Claims Data will be finalized 3 months after close of season i.e. 30th June;
- Target farmers - small scale and communal farmers. Commercial farmers (those with hectarage above 10ha) will be considered on a case by case basis;
- Only the dry day and flowering cover will be covered in the coming season;
- Each farmer or group of farmers will need to provide coordinates so as to provide an appropriate premium rate for each area. Premium rates are applicable for a 10 km radius;
- During the claims assessment, all affected areas (i.e. where the triggers have been activated) will be subject to a ground proofing exercise to assess the extent of the yield loss;
- The maximum benefit will be up to 85% of the sum insured;
- Best farming practice to be adhered to and non-adherence will result in the contract being void;

An overview of the triggers and rates used in calculating ZimNat weather index insurance is provided in Tables A17 and A18 below:

**Table A17: Summary of triggers**

| CROP | MAIZE | PARPRIKA | SORGHUM | SOYA | SUGAR BEANS |
|---|---|---|---|---|---|
| Contract start date | November 15, 2016 | November 15, 2016 | December 10, 2016 | December 15, 2016 | December 15, 2016 |
| Contract end date | March 31, 2017 | March 31, 2017 | March 31, 2017 | March 31, 2017 | March 31, 2017 |
| Start of dry day contract period | 15 December 2016 | 15 December 2016 | 15 January 2016 | 15 December 2016 | 15 December 2016 |
| End of dry day contract period | 31 March 2017 | 31 March 2017 | 31 March 2017 | 31 March 2017 | 31 March 2017 |
| Dry day maximum payout (%) | 85% | 85% | 85% | 85% | 85% |
| Dry day trigger | **Dependent on area (See Summary Premium Rate Structure Excel Book)** | | | | |
| Dry day exit | | | | | |
| Dry day payout rate | | | | | |
| Start of flowering period | 1 February 2017 | 1 January 2017 | 20 January 2017 | 20 January 2017 | 20 January 2017 |
| End of flowering period | 29 February 2017 | 31 January 2017 | 28 February 2017 | 16 February 2017 | 16 February 2017 |
| Flowering period maximum payout (%) | 85% | 85% | 85% | 85% | 85% |
| Flowering period trigger | **Dependent on area (See Summary Premium Rate Structure Excel Book)** | | | | |
| Flowering period exit | | | | | |
| Flowering period payout rate (%) | | | | | |
| Dry day definition (mm) | 2.30 | 2.20 | 2.00 | 2.20 | 2.20 |

[411] NOAA EDMC. 2017. Climate Prediction Centre (CPC) Africa Rainfall Climatology Version 2.0 (ARC2). Available on: https://data.noaa.gov/dataset/climate-prediction-center-cpc-africa-rainfall-climatology-version-2-0-arc2 (Accessed 5 May 2017)

**Table A18: Summary of rates**

MAIZE

| | Sum Insured Split | | Acturus | Banket | Goromonzi | Kadoma | Chinhoyi | Bindura | Chiweshe |
|---|---|---|---|---|---|---|---|---|---|
| Maximum Level Of Indemnity | | | **85%** | **85%** | **85%** | **85%** | **85%** | **85%** | **85%** |
| Assessment will be done at the end of the season | | | | | | | | | |
| DRY DAYS | 60% | TRIGGER (days) | 25 | 25 | 25 | 30 | 25 | 30 | 25 |
| | | EXIT (days) | 45 | 45 | 45 | 45 | 45 | 45 | 45 |
| | | RATE | 10% | 7% | 10% | 12% | 8% | 13% | 7% |
| FLOWERING | 40% | TRIGGER (mm) | 40 | 45 | 40 | 40 | 60 | 45 | 60 |
| | | EXIT (mm) | 0 | 0 | 0 | 0 | 20 | 0 | 20 |
| | | RATE | 11% | 9% | 11% | 11% | 13% | 9% | 13% |
| **OVERALL** | | | **11%** | **8%** | **11%** | **12%** | **10%** | **11%** | **10%** |

SOYA

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|---|---|---|---|---|---|---|---|---|---|
| DRY DAYS | 60% | TRIGGER (days) | 25 | 25 | 25 | 25 | 25 | 30 | 25 |
| | | EXIT (days) | 45 | 45 | 45 | 45 | 45 | 45 | 45 |
| | | RATE | 7% | 3% | 7% | 10% | 4% | 10% | 3% |
| FLOWERING | 40% | TRIGGER (mm) | 60 | 40 | 60 | 40 | 60 | 60 | 40 |
| | | EXIT (mm) | 20 | 0 | 20 | 0 | 20 | 20 | 0 |
| | | RATE | 12% | 3% | 12% | 7% | 6% | 8% | 5% |
| **OVERALL** | | | **9%** | **3%** | **9%** | **9%** | **5%** | **9%** | **4%** |

SORGHUM

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|---|---|---|---|---|---|---|---|---|---|
| DRY DAYS | 60% | TRIGGER (days) | 20 | 20 | 20 | 25 | 20 | 25 | 20 |
| | | EXIT (days) | 45 | 45 | 45 | 45 | 45 | 45 | 45 |
| | | RATE | 13% | 7% | 13% | 10% | 7% | 12% | 7% |
| FLOWERING | 40% | TRIGGER (mm) | 60 | 100 | 60 | 60 | 100 | 100 | 100 |
| | | EXIT (mm) | 20 | 20 | 20 | 20 | 20 | 20 | 20 |
| | | RATE | 11% | 8% | 11% | 10% | 7% | 10% | 8% |
| **OVERALL** | | | **12%** | **7%** | **12%** | **10%** | **7%** | **11%** | **8%** |

SUGAR BEANS

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|---|---|---|---|---|---|---|---|---|---|
| DRY DAYS | 60% | TRIGGER (days) | 20 | 20 | 20 | 25 | 20 | 25 | 20 |
| | | EXIT (days) | 45 | 45 | 45 | 45 | 45 | 45 | 45 |
| | | RATE | 12% | 6% | 12% | 9% | 7% | 11% | 7% |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| FLOWERING | 40% | TRIGGER (mm) | 60 | 80 | 60 | 40 | 80 | 60 | 80 |
| | | EXIT (mm) | 20 | 20 | 20 | 0 | 20 | 20 | 20 |
| | | RATE | 12% | 10% | 12% | 7% | 11% | 8% | 11% |
| **OVERALL** | | | **12%** | **8%** | **12%** | **8%** | **9%** | **10%** | **8%** |

PAPRIKA

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|---|---|---|---|---|---|---|---|---|---|
| DRY DAYS | 60% | TRIGGER (days) | 25 | 30 | 25 | 30 | 25 | 30 | 30 |
| | | EXIT (days) | 45 | 45 | 45 | 45 | 45 | 45 | 45 |
| | | RATE | 10% | 7% | 10% | 12% | 8% | 13% | 7% |
| FLOWERING | 40% | TRIGGER (mm) | 90 | 90 | 90 | 80 | 90 | 80 | 90 |
| | | EXIT (mm) | 20 | 20 | 20 | 20 | 20 | 20 | 20 |
| | | RATE | 10% | 5% | 10% | 10% | 5% | 10% | 8% |
| **OVERALL** | | | **10%** | **7%** | **10%** | **11%** | **7%** | **12%** | **8%** |

MAIZE

| | Sum Insured Split | | Lions Den | Mhangura - Doma | Raffingora | Matepatepa | Hurungwe | Glendale | Concession |
|---|---|---|---|---|---|---|---|---|---|
| Maximum Level Of Indemnity | | | **85%** | **85%** | **85%** | **85%** | **85%** | **85%** | **85%** |
| Assessment will be done at the end of the season | | | | | | | | | |
| DRY DAYS | 60% | TRIGGER (days) | 25 | 25 | 30 | 25 | 25 | 30 | 30 |
| | | EXIT (days) | 45 | 45 | 45 | 45 | 45 | 45 | 45 |
| | | RATE | 7% | 8% | 10% | 9% | 7% | 12% | 12% |
| FLOWERING | 40% | TRIGGER (mm) | 45 | 45 | 60 | 45 | 60 | 45 | 45 |
| | | EXIT (mm) | 0 | 0 | 20 | 0 | 20 | 0 | 0 |
| | | RATE | 8% | 9% | 9% | 9% | 7% | 11% | 11% |
| **OVERALL** | | | **8%** | **9%** | **10%** | **9%** | **7%** | **12%** | **12%** |

SOYA

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|---|---|---|---|---|---|---|---|---|---|
| DRY DAYS | 60% | TRIGGER (days) | 25 | 25 | 25 | 25 | 25 | 30 | 30 |
| | | EXIT (days) | 45 | 45 | 45 | 45 | 45 | 45 | 45 |
| | | RATE | 3% | 5% | 9% | 5% | 3% | 9% | 9% |
| FLOWERING | 40% | TRIGGER (mm) | 40 | 60 | 60 | 40 | 40 | 60 | 60 |
| | | EXIT (mm) | 0 | 20 | 20 | 0 | 0 | 20 | 20 |
| | | RATE | 5% | 9% | 8% | 7% | 3% | 11% | 13% |
| **OVERALL** | | | **4%** | **6%** | **8%** | **6%** | **3%** | **10%** | **11%** |

SORGHUM

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|---|---|---|---|---|---|---|---|---|---|
| DRY DAYS | 60% | TRIGGER (days) | 20 | 20 | 20 | 20 | 20 | 25 | 25 |
| | | EXIT (days) | 45 | 45 | 45 | 45 | 45 | 45 | 45 |
| | | RATE | 6% | 8% | 10% | 9% | 6% | 11% | 11% |
| FLOWERING | 40% | TRIGGER (mm) | 100 | 100 | 100 | 80 | 60 | 80 | 80 |
| | | EXIT (mm) | 20 | 20 | 20 | 20 | 20 | 20 | 20 |
| | | RATE | 10% | 7% | 5% | 11% | 3% | 9% | 10% |
| **OVERALL** | | | **7%** | **8%** | **8%** | **10%** | **5%** | **10%** | **10%** |

SUGAR BEANS

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|---|---|---|---|---|---|---|---|---|---|
| DRY DAYS | 60% | TRIGGER (days) | 20 | 20 | 20 | 20 | 20 | 25 | 25 |
| | | EXIT (days) | 45 | 45 | 45 | 45 | 45 | 45 | 45 |
| | | RATE | 5% | 7% | 9% | 8% | 5% | 10% | 11% |
| FLOWERING | 40% | TRIGGER (mm) | 60 | 80 | 80 | 40 | 80 | 60 | 60 |
| | | EXIT (mm) | 20 | 20 | 20 | 0 | 20 | 20 | 20 |
| | | RATE | 7% | 10% | 11% | 7% | 4% | 11% | 14% |
| **OVERALL** | | | **6%** | **9%** | **10%** | **8%** | **5%** | **11%** | **12%** |

PAPRIKA

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|---|---|---|---|---|---|---|---|---|---|
| DRY DAYS | 60% | TRIGGER (days) | 30 | 25 | 30 | 25 | 30 | 30 | 30 |
| | | EXIT (days) | 45 | 45 | 45 | 45 | 45 | 45 | 45 |
| | | RATE | 7% | 8% | 10% | 9% | 7% | 12% | 12% |
| FLOWERING | 40% | TRIGGER (mm) | 90 | 90 | 90 | 90 | 90 | 90 | 90 |
| | | EXIT (mm) | 20 | 20 | 20 | 20 | 20 | 20 | 20 |
| | | RATE | 9% | 8% | 5% | 5% | 6% | 10% | 10% |
| **OVERALL** | | | **8%** | **8%** | **8%** | **7%** | **7%** | **11%** | **11%** |

MAIZE

| | Sum Insured Split | | Norton | Mazowe | Kwekwe | Guruve | Karoi | Magunje | Mvurwi |
|---|---|---|---|---|---|---|---|---|---|
| Maximum Level Of Indemnity | | | **85%** | **85%** | **85%** | **85%** | **85%** | **85%** | **85%** |
| Assessment will be done at the end of the season | | | | | | | | | |
| DRY DAYS | 60% | TRIGGER (days) | 30 | 30 | 30 | 30 | 30 | 30 | 30 |
| | | EXIT (days) | 45 | 45 | 45 | 45 | 45 | 45 | 45 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | RATE | 11% | 11% | 26% | 12% | 7% | 7% | 10% |
| FLOWERING | 40% | TRIGGER (mm) | 40 | 40 | 40 | 60 | 40 | 40 | 60 |
| | | EXIT (mm) | 0 | 0 | 0 | 20 | 0 | 0 | 20 |
| | | RATE | 12% | 8% | 24% | 9% | 3% | 3% | 9% |
| **OVERALL** | | | **11%** | **10%** | **25%** | **11%** | **6%** | **6%** | **10%** |

SOYA

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|---|---|---|---|---|---|---|---|---|---|
| DRY DAYS | 60% | TRIGGER (days) | 25 | 25 | 25 | 25 | 25 | 25 | 25 |
| | | EXIT (days) | 45 | 45 | 45 | 45 | 45 | 45 | 45 |
| | | RATE | 12% | 9% | 29% | 9% | 4% | 4% | 9% |
| FLOWERING | 40% | TRIGGER (mm) | 40 | 40 | 40 | 80 | 80 | 80 | 80 |
| | | EXIT (mm) | 0 | 0 | 0 | 20 | 20 | 20 | 20 |
| | | RATE | 10% | 9% | 13% | 12% | 10% | 10% | 13% |
| **OVERALL** | | | **11%** | **9%** | **23%** | **10%** | **7%** | **6%** | **10%** |

SORGHUM

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|---|---|---|---|---|---|---|---|---|---|
| DRY DAYS | 60% | TRIGGER (days) | 20 | 20 | 20 | 25 | 20 | 20 | 20 |
| | | EXIT (days) | 45 | 45 | 45 | 45 | 45 | 45 | 45 |
| | | RATE | 13% | 12% | 32% | 9% | 6% | 6% | 10% |
| FLOWERING | 40% | TRIGGER (mm) | 60 | 60 | 60 | 100 | 60 | 60 | 100 |
| | | EXIT (mm) | 20 | 20 | 20 | 20 | 20 | 20 | 20 |
| | | RATE | 12% | 13% | 18% | 6% | 3% | 3% | 7% |
| **OVERALL** | | | **12%** | **13%** | **26%** | **8%** | **5%** | **5%** | **9%** |

SUGAR BEANS

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|---|---|---|---|---|---|---|---|---|---|
| DRY DAYS | 60% | TRIGGER (days) | 25 | 20 | 25 | 20 | 20 | 20 | 20 |
| | | EXIT (days) | 45 | 45 | 45 | 45 | 45 | 45 | 45 |
| | | RATE | 8% | 13% | 26% | 11% | 6% | 5% | 9% |
| FLOWERING | 40% | TRIGGER (mm) | 40 | 40 | 40 | 80 | 80 | 80 | 80 |
| | | EXIT (mm) | 0 | 0 | 0 | 20 | 20 | 20 | 20 |
| | | RATE | 10% | 9% | 14% | 10% | 8% | 8% | 10% |
| **OVERALL** | | | **9%** | **12%** | **21%** | **10%** | **7%** | **6%** | **10%** |

PAPRIKA

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| DRY DAYS | 60% | TRIGGER (days) | 30 | 25 | 25 | 30 | 25 | 25 | 30 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | EXIT (days) | 45 | 45 | 45 | 45 | 45 | 45 | 45 |
| | | RATE | 11% | 11% | 30% | 12% | 8% | 8% | 10% |
| FLOWERING | 40% | TRIGGER (mm) | 80 | 90 | 50 | 90 | 90 | 90 | 90 |
| | | EXIT (mm) | 20 | 20 | 0 | 20 | 20 | 20 | 20 |
| | | RATE | 10% | 9% | 12% | 8% | 7% | 6% | 10% |
| **OVERALL** | | | **11%** | **10%** | **23%** | **10%** | **8%** | **7%** | **10%** |

MAIZE

| | Sum Insured Split | | Beatrice | Chegutu | Zvimba | Trelawnly | Macheke | Murehwa | Kariba |
|---|---|---|---|---|---|---|---|---|---|
| Maximum Level Of Indemnity | | | **85%** | **85%** | **85%** | **85%** | **85%** | **85%** | **85%** |
| Assessment will be done at the end of the season | | | | | | | | | |
| DRY DAYS | 60% | TRIGGER (days) | 30 | 30 | 25 | 25 | 30 | 30 | 30 |
| | | EXIT (days) | 45 | 45 | 45 | 45 | 45 | 45 | 45 |
| | | RATE | 10% | 10% | 9% | 11% | 9% | 14% | 11% |
| FLOWERING | 40% | TRIGGER (mm) | 40 | 40 | 45 | 40 | 40 | 40 | 45 |
| | | EXIT (mm) | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | RATE | 14% | 17% | 12% | 11% | 18% | 11% | 8% |
| **OVERALL** | | | **12%** | **13%** | **10%** | **11%** | **13%** | **13%** | **10%** |

SOYA

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| DRY DAYS | 60% | TRIGGER (days) | 30 | 25 | 25 | 25 | 30 | 30 | 25 |
| | | EXIT (days) | 45 | 45 | 45 | 45 | 45 | 45 | 45 |
| | | RATE | 7% | 13% | 5% | 8% | 5% | 12% | 11% |
| FLOWERING | 40% | TRIGGER (mm) | 40 | 40 | 60 | 60 | 60 | 40 | 80 |
| | | EXIT (mm) | 0 | 0 | 20 | 20 | 20 | 0 | 20 |
| | | RATE | 9% | 9% | 9% | 9% | 14% | 8% | 6% |
| **OVERALL** | | | **8%** | **11%** | **7%** | **8%** | **8%** | **10%** | **9%** |

SORGHUM

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| DRY DAYS | 60% | TRIGGER (days) | 25 | 25 | 20 | 20 | 25 | 25 | 25 |
| | | EXIT (days) | 45 | 45 | 45 | 45 | 45 | 45 | 45 |
| | | RATE | 13% | 8% | 8% | 12% | 9% | 15% | 9% |
| FLOWERING | 40% | TRIGGER (mm) | 60 | 60 | 80 | 100 | 60 | 80 | 100 |
| | | EXIT (mm) | 20 | 20 | 20 | 20 | 20 | 20 | 20 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | RATE | 10% | 11% | 9% | 11% | 10% | 12% | 5% |
| **OVERALL** | | | **12%** | **9%** | **9%** | **12%** | **10%** | **14%** | **7%** |

SUGAR BEANS

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|---|---|---|---|---|---|---|---|---|---|
| DRY DAYS | 60% | TRIGGER (days) | 25 | 25 | 20 | 20 | 25 | 25 | 20 |
| | | EXIT (days) | 45 | 45 | 45 | 45 | 45 | 45 | 45 |
| | | RATE | 13% | 9% | 7% | 11% | 11% | 14% | 12% |
| FLOWERING | 40% | TRIGGER (mm) | 40 | 40 | 60 | 60 | 40 | 40 | 80 |
| | | EXIT (mm) | 0 | 0 | 20 | 20 | 0 | 0 | 20 |
| | | RATE | 10% | 9% | 9% | 9% | 6% | 8% | 5% |
| **OVERALL** | | | **12%** | **9%** | **8%** | **10%** | **9%** | **12%** | **9%** |

PAPRIKA

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| DRY DAYS | 60% | TRIGGER (days) | 30 | 30 | 25 | 25 | 30 | 30 | 30 |
| | | EXIT (days) | 45 | 45 | 45 | 45 | 45 | 45 | 45 |
| | | RATE | 10% | 10% | 9% | 10% | 9% | 14% | 11% |
| FLOWERING | 40% | TRIGGER (mm) | 50 | 90 | 90 | 90 | 80 | 90 | 90 |
| | | EXIT (mm) | 0 | 20 | 20 | 20 | 20 | 20 | 20 |
| | | RATE | 6% | 9% | 7% | 7% | 12% | 9% | 5% |
| **OVERALL** | | | **9%** | **10%** | **8%** | **9%** | **10%** | **12%** | **8%** |

MAIZE

| | Sum Insured Split | | Selous | Headlands | UMP | Gokwe | Chakari |
|---|---|---|---|---|---|---|---|
| Maximum Level Of Indemnity | | | **85%** | **85%** | **85%** | **85%** | **85%** |
| Assessment will be done at the end of the season | | | | | | | |
| DRY DAYS | 60% | TRIGGER (days) | 30 | 30 | 30 | 25 | 25 |
| | | EXIT (days) | 45 | 45 | 45 | 45 | 45 |
| | | RATE | 12% | 18% | 9% | 9% | 11% |
| FLOWERING | 40% | TRIGGER (mm) | 40 | 40 | 40 | 45 | 40 |
| | | EXIT (mm) | 0 | 0 | 0 | 0 | 0 |
| | | RATE | 19% | 19% | 12% | 9% | 10% |
| **OVERALL** | | | **15%** | **19%** | **10%** | **9%** | **11%** |

SOYA

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| DRY DAYS | 60% | TRIGGER (days) | 30 | 30 | 25 | 25 | 25 |
| | | EXIT (days) | 45 | 45 | 45 | 45 | 45 |
| | | RATE | 7% | 15% | 11% | 6% | 9% |
| FLOWERING | 40% | TRIGGER (mm) | 40 | 40 | 60 | 80 | 60 |
| | | EXIT (mm) | 0 | 0 | 20 | 20 | 20 |
| | | RATE | 9% | 8% | 11% | 10% | 10% |
| **OVERALL** | | | **8%** | **12%** | **11%** | **7%** | **9%** |

SORGHUM

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| DRY DAYS | 60% | TRIGGER (days) | 25 | 20 | 25 | 20 | 20 |
| | | EXIT (days) | 45 | 45 | 45 | 45 | 45 |
| | | RATE | 10% | 23% | 9% | 9% | 11% |
| FLOWERING | 40% | TRIGGER (mm) | 60 | 60 | 60 | 100 | 80 |
| | | EXIT (mm) | 20 | 20 | 20 | 20 | 20 |
| | | RATE | 14% | 11% | 9% | 7% | 10% |
| **OVERALL** | | | **12%** | **18%** | **9%** | **8%** | **10%** |

SUGAR BEANS

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| DRY DAYS | 60% | TRIGGER (days) | 25 | 25 | 25 | 20 | 20 |
| | | EXIT (days) | 45 | 45 | 45 | 45 | 45 |
| | | RATE | 10% | 19% | 8% | 9% | 12% |
| FLOWERING | 40% | TRIGGER (mm) | 40 | 40 | 60 | 80 | 60 |
| | | EXIT (mm) | 0 | 0 | 20 | 20 | 20 |
| | | RATE | 10% | 8% | 12% | 8% | 10% |
| **OVERALL** | | | **10%** | **14%** | **10%** | **9%** | **11%** |

PAPRIKA

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| DRY DAYS | 60% | TRIGGER (days) | 30 | 25 | 30 | 25 | 25 |
| | | EXIT (days) | 45 | 45 | 45 | 45 | 45 |
| | | RATE | 11% | 22% | 9% | 9% | 11% |
| FLOWERING | 40% | TRIGGER (mm) | 50 | 50 | 90 | 80 | 90 |
| | | EXIT (mm) | 0 | 0 | 20 | 20 | 20 |
| | | RATE | 7% | 5% | 6% | 10% | 7% |
| **OVERALL** | | | **9%** | **15%** | **8%** | **9%** | **10%** |

## Appendix 16.: Weather and seasonal forecasting

The daily public forecast undertaken by MSD relies on a number of sources of information:

- Global forecasts produced by GFS (NOAA in the US) and ECMWF (in the UK) are downloaded from the internet and via EUMETSAT
- Satellite observations (Meteosat 2nd generation) from the internet and EUMETSAT
- Regional forecasts via the regional service centre SAWS (South Africa) – this is a Unified Model run under license from the UK meteorological office
- Observations collected and phoned in from synoptic weather stations around Zimbabwe

The above sources are synthesized and discussed by trained forecasters who issue the daily forecast. This involves taking the forecasts and comparing them to what actually occurred in Zimbabwe as measured by the meteorological stations, which allows the forecasters to adjust which forecasts are more believable or expected to be more skillful. This system has the advantage that forecaster experience is a key part of the forecasting process, but this process remains inherently qualitative – each source of information is qualitatively weighed by the forecaster and the resulting forecast does not give precise details on the amount of rainfall and exactly where it is expected to fall.

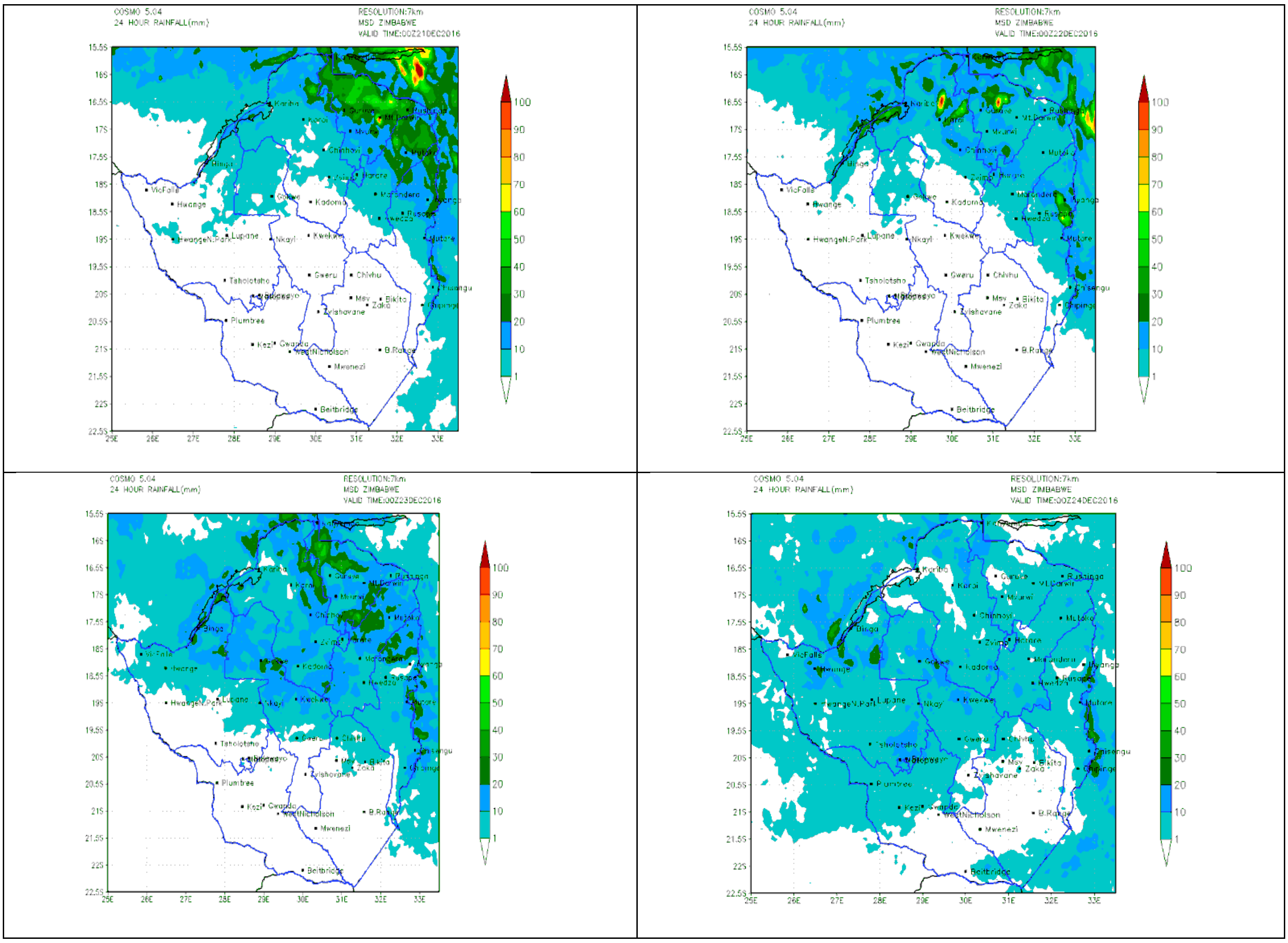



**Figure A11:** Downscaled weather forecast (using COSMO regional climate model)

MSD, with support from the Oxfam UNDP/GEF project, has however been running **regional climate models** (WRF and COSMO) in order to downscale the global forecasts (by running a finer/higher resolution regional model) and provide quantitative estimates of rainfall (see figure 2). These models require downloaded GFS data (boundary conditions), which can be uploaded and run on the Zimbabwe High Performance Computing Centre (ZHPC) to develop the forecasts. However, the longer forecasts (10 days) require a significant amount of GFS data to be downloaded and bandwidth is a significant capacity constraint to running the models for this forecast.

For the **3-day forecast** 72 hours of data are downloaded, which is less data intensive than for the Agromet bulletin (used by the national early warning unit), which uses the **10-day forecast** produced every Wednesday. The downloading and sync processes are all automated via scripts. Processing and downloading time are dependent on the size of data and area in focus as well as the forecasting range. For the Agromet 10 day forecast, it takes approximately 10 hours run time and about 3 hours of downloading which gives a total of close to 13 hours to obtain a 10-day forecast. The size of output data is also dependent on the range of forecast days, but for the Agromet forecast it's approximately 90GB available for downloading. **Seasonal forecasts** are produced using statistical relationships between sea surface temperatures SSTs (notably in the Pacific, Atlantic and Indian oceans (see Table A19) and observed rainfall/temperatures over Zimbabwe. These relationships are developed using standard tools (GeoCOF and SYSTAT) and discussed in regional fora (SARCOF).

**Table A19:** Typical rainfall conditions in Zimbabwe under different global SST patterns.

| Eastern Pacific SST during DJF | Rainfall Prospects |
|---|---|
| Warm | Enhanced probability of poor rains |
| Neutral or cold | Good chance of average to above average rainfall |
| **Central Equatorial Indian Ocean** | |
| Warm | Low chances of rain |
| Cold/neutral | Enhanced chance of a good season |
| **Tropical Atlantic Ocean** | |
| Warm | High chances of average to above average rainfall |
| Cold/Neutral | Enhanced probability of poor rains |

Although MSD does not use traditional indicators in generating seasonal forecasts, it is fully aware of the existence of such practices in many parts of the country (see Table A20). An example of the **seasonal forecast**, its verification and how it is used by other organisations is presented in Figure A12. In the Zimbabwe context it is also worth noting that the methods and applications of seasonal forecasts are constantly evolving. A recent paper illustrates the advantages of using more rainfall stations when linking rainfall variability and remote SSTs[412], and the application of seasonal forecasts has driven new decision centric approaches (which are simpler and easier to understand) to the binary prediction of drought[413].

**Table A20:** Indigenous seasonal forecasting indicators

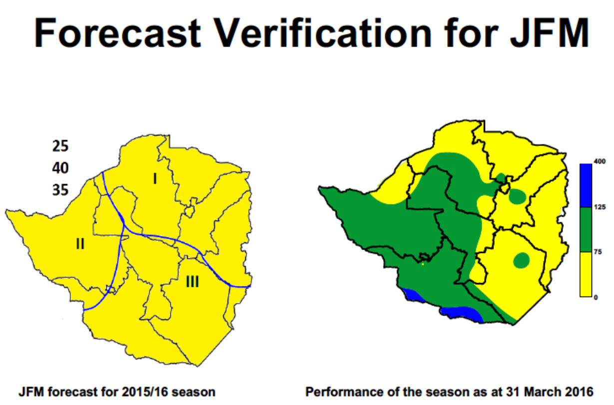
| Feature | Observation | Implication |
|---|---|---|
| **Plants** | Marula/Mupfura, *Mopane/Musharu, Mutcha,* Monkey orange and Baobab Trees - significant fruiting.<br><br>Indigenous trees when producing new shoots, flowers and leaves.<br><br>Mubarati, Mupanda, Mukamba and Baobab trees- significant flowering. | It symbolizes poor rains in the coming season.<br><br>It symbolizes the onset of the planting season.<br><br>It symbolizes good rain season. |

412 Mamombe et al. (2017) Rainfall variability over Zimbabwe and its relation to large-scale atmosphere–ocean processes. Int. J. Climatol. 37: 963–971. DOI: 10.1002/joc.4752

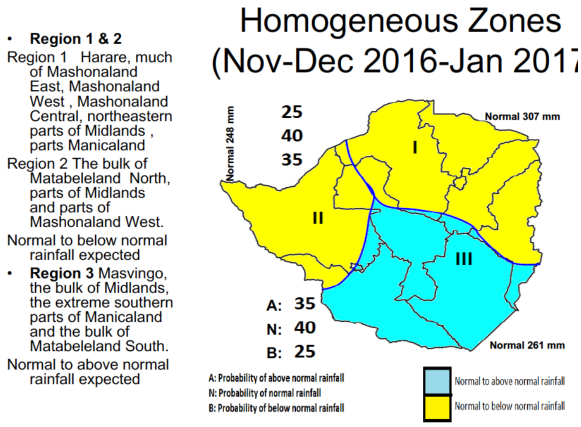
413 Leonard S. Unganai, Jessica Troni, Desmond Manatsa & Daisy Mukarakate (2013) Tailoring seasonal climate forecasts for climate risk management in rainfed farming systems of southeast Zimbabwe, Climate and Development,5:2, 139-152, DOI: 10.1080/17565529.2013.801823

| **Feature** | **Observation** | **Implication** |
|---|---|---|
| | Buffalo thorn/*Guhunga /Chitataunga/ chinanga)* - white flowers and cream like flowers. | White flowers symbolises poor rains and cream flowers symbolises good rains in the coming season. |
| **Birds** | *Phukwani*- singing<br><br>*Stock/Shuramurove/Musore*- Large numbers | Indicating good rains in the coming season.<br><br>Indicating a good rainfall season. |
| | Weaver Bird-Building its nests near the river bed | Indicating poor rains in the coming season. |
| **Insects** | Insects- significant amount of Honeycomb like waxy cells on Mopane (*Zvindali*) leaves.<br><br>*Marora* (Bees) - migrate to other areas e.g. highlands.<br>Armyworms- significant number of army worms. | Symbolizing a good rain season<br><br>Symbolizes a poor rain season<br><br>Symbolizes a good rain season. |
| **Fish** | *Shambira/ Gwiramvuu* – found in large dams downstream, they move to shallow dams upstream. | Symbolizes good rains season. |
| **Reptiles** | Bullfrog *(Dzetse*) – produces a certain sound. | Symbolizes high rainfall in that season. |
| **Animals** | Baboons- having a lot of kids. | Symbolizes a good rain season with a bumper harvest. |
| **People** | Chiefs and kraal heads – performing traditional ceremonies (*Mukwerera/Musoso*). | There will be high rainfall that season. |
| **Environment** | Hazy (*Mauma/ Unga*)-an increase in the haziness during summer days. | Indicate that there will be high rainfall in that season. |
| **Birds** | Ducks – Playing with mud<br><br>*Dendera/ Riti* - Singing during dawn<br><br>Swallow bird (*Nyenganyenga*)- Flocks seen flying all over the area.<br><br>Cuckoo bird (*Chochomera, Kohwera*) – sings. | Symbolizes that there will be rainfall in a days' time.<br><br>It symbolizes Fog or mist and accompanied with drizzle that day.<br><br>Symbolizes heavy rains in a short period of time i.e. that day.<br><br>Indicate imminent onset of rainfall its sound reflects the cluttering rainfall. |
| **Reptiles** | Toad (*Rwangachena*)- a white toad if the produces a certain crinkling (*cheche-re-re-cheche-re-re-r*) sound. | Symbolizes imminent rainfall in a day or two. |
| **Insects** | Ants (*Masvosve*) – If they shift their eggs and young ones to a safe area. | Indicating that it will rain in a short period of time. |

| Feature | Observation | Implication |
|---|---|---|
| | Spider (*Dzvatsvatsva*) – if they are found in significant numbers running around. | Indicates that imminent rainfall. |
| **Animals** | Cats (*Kitsi*) - if it shifts its kittens to a safer location. | Symbolizes rainfall in a short period of time i.e. that day |
| **Weather** | Easterly winds (*Mugura Save/Nhuruka*)<br><br>Hot and cold- Alternation of hot and cold usually in Summer.<br><br>Morning fog/ mist on hills and mountains.<br><br>Cumulonimbus clouds (*Njuzu/ Mvumi*)- three sets of these clouds positioned West, North and South<br><br>Halo around the Sun or Moon | Symbolizes rainfall within a short period of time in a day or two.<br><br>Symbolizes rainfall in a short period of time.<br><br>Symbolizes imminent rainfall is expected in a day or two.<br>Symbolizes imminent rainfall in a day or two.<br><br>Symbolizes heavy rains in a short period of time i.e. that day. |




(a)




(b)

**Implications of the forecast for the 2016/17 rainfall season**

- Inputs, including small grains should be distributed to all regions (a) by the end of September 2016 in Matabeleland South, Masvingo, Midlands and southern districts of Manicaland and (b) By the end of October for the rest of the country;
- In view of the moisture availability and suitable temperature thresholds, those with water should not wait for the main rains to fall. They can plant any time now;

**Implications cont………**

- **Please Note:**
- **Despite the high chances of higher than usual rains this season, in terms of national strategic planning and development,**
- **Zimbabwe should always expect, and plan for, one form of drought or another. It is now extremely rare for the whole country to experience the same weather conditions.**
- There is need to continue with water harvesting programmes already underway, especially those in agro-ecological zones IV and V. We should keep in mind that there are indications of deterioration in the rainfall amounts as the season progresses.

**Figure A12:** Seasonal forecast (b), its verification (a) and derived implications.

## Appendix x17.: Classification of ZAIP investments based on climate-sensitive categories and screening criteria based related to scale/funding adequacy

| Investment program | Category | US$ '000 |
|---|---|---|
| **1.0 Increasing production and productivity through improved management and sustainable use of land, water, forestry and wildlife resources** | | **1,056,940** |
| 1.1 Enhance land tenure security through modifications to the 99-year leases | **5 (a)** | 3,000 |
| 1.2 Surveying and demarcation of farms | **5 (a)** | 35,000 |
| 1.3 Rehabilitation of existing priority sources of water (dams, rivers, boreholes), for irrigation | **1 (b) A** | 100,000 |
| 1.4 Rehabilitation of irrigation | **1 (b) A** | 900,010 |
| 1.5 Surveying and designing water and electricity distribution system to serve new land ownership | **5 (b)** | 2,000 |
| 1.6 Conduct a study to quantify Small and Large scale irrigation infrastructure | **3 (b) A** | 1,930 |
| 1.7 Strengthen law enforcement for forestry, fisheries and wild life management | **4 (c) A** | 15,000 |
| **2.0 Increased participation of farmers in domestic and export markets through development of an efficient agricultural marketing system and an enabling environment for competitive agricultural production, investment (Domestic and FDI) and Trade** | | **2,726,473** |
| 2.1 Promote rural savings, domestic lending and international credit | **5 (d)** | 350,000 |
| 2.2 Contract farming-credit schemes (tobacco, sugar, soya and cotton) | **5 (a) (b)** | 895,569 |
| 2.3 Crop and livestock insurance schemes | **4 (c) B** | 3,210 |
| 2.4 Operationalizing the Warehouse System and ZIMACE | **5 (d)** | 5,000 |
| 2.5 Commodity association competitiveness development | **5 (d)** | 53,700 |
| 2.6 Concessionary Development Finance through PPPs | **5 (d)** | 400,000 |
| 2.7 Strengthen market information | **5 (d)** | 4,480 |
| 2.8 Internet/ Mobile based crop and livestock prices dissemination | **5 (d)** | 240 |
| 2.9 Rehabilitation of Government livestock facilities | **1 (c) B** | 2,800 |
| 2.10 Baseline survey to prioritize the key market infrastructure (feeder roads, rail lines, electricity) | **5 (d)** | 50 |
| 2.11 Improving transport, market and storage infrastructure | **5 (d)** | 10,000 |
| 2.12 Rehabilitation of 18000km or rural roads | **5 (d)** | 991,024 |
| 2.13 More communal farmers adopt contract farming | **4 (a) (b) A** | 10,400 |
| **3.0 Increasing food supply, reduce food insecurity and malnutrition among vulnerable people, and strengthen responses to food crisis** | | **350,600** |
| 3.1 Policy instruments which protect and enhance food and nutrition security particularly amongst the most vulnerable are formulated, and inform government and non-government decision making | **4 (a) (b) C** | 10,000 |
| 3.2 Ensuring that where social protection (including social assistance programs) is implemented, it must contribute and enhance nutrition and food security of the most vulnerable in the ST and MT. | **2 (d) C** | 318,600 |
| 3.3 Ensuring the provision of safe and wholesome food to all. Consequently, all food whether imported or locally produced, shall meet both national public health legislation and international standards for quality safety. | **2 (a) C** | 10,000 |
| 3.4 Ensuring a national integrated food and nutrition security information system that not only provides timely and reliable information on food and nutrition security situation and effectiveness of programs but also informs decision-making. | **2 (d) C** | 5,000 |
| 3.5 Enhancing and strengthening national capacity in food and nutrition security, primarily through supporting and reinforcing local community capacity and responsibility for food and nutrition | **3 (d) C** | 4,500 |

| | | |
|---|---|---|
| security, applied context-specific research and learning and multi-sectoral professional training in food and nutrition security. | | |
| 3.6 Policy instruments which protect and enhance food and nutrition security particularly amongst the most vulnerable are formulated and inform government and non-government decision making | **3 (d) C** | 2,500 |
| **4.0 Improving Agricultural Research, Technology Dissemination and Adoption** | | **418,054** |
| 4.1 Retrain extension workers and farmers (private, public & NGO) | **3 (a) C** | 102,706 |
| 4.2 Disseminate extension messages (print, TV, radio, e-extension) | **3 (a) C** | 18,617 |
| 4.3 Strengthen farmer - extension linkages | **3 (a) C** | 68,843 |
| 4.4 Capacity building for farmers using lead farmers | **3 (a) C** | 28,563 |
| 4.5 Refurbish existing and develop additional appropriate research infrastructure and systems | **3 (a) C** | 6 300 |
| 4.6 Enhance Research & extension interface | **3 (a) C** | 6,376 |
| 4.7 Livestock development (Breeding Stock) | **1 (c) C** | 95,856 |
| 4.8 Design manuals for best practices in crop, livestock production | **4 (c) C** | 20,000 |
| 4.9 Review of tuition materials for extension staff | **4 (a) (c) C** | 100 |
| 4.10 In-service training for public extension staff | **4 (d) C** | 25,000 |
| 4.11 Re-equip training institutes | **4 (d) C** | 50,000 |
| 4.12 Strengthen farmer associations | **4 (d) C** | 5,000 |
| **5.0 Coordination, Monitoring and Evaluation** | | **138,272** |
| 5.1 Coordination and implementation | **5 (d)** | 82,963 |
| 5.2 Monitoring and Evaluation | **5 (d)** | 55,309 |
| **Grand total** | | **4,690,339** |
| | | |

## Appendix 18.: Low cost weather stations

One initiative implementing low-cost AWS is the Trans African Hydro-Meteorological Observatory (TAHMO)[414], which intends to install 20,000 on-the-ground sensing stations across the African continent. These stations are designed to provide rainfall, temperature, and other critical data with robust redundant sensors and real-time cell-phone enabled data access. Interviews with the TAHMO director John Selker indicated that:

- TAHMO stations are often paired with existing manual stations to ensure that there is continuity in the data record;
- Stations can be owned by the government, but data are shared. Data is sent to the cloud and automatically downloaded to local servers using API every hour (5 minute data);
- Equipment: Currently all sensors are WMO compliant except barometer which is being replaced by one that is;
- Costs: 3-year operating all in one cost (including installation, local engineer/field staff for services, O&M and installation) is $3,500. Less if installation is conducted - $2,500-3,000 (station bought on its own (from Decagon in this example)). With $200 per year additional for SIM (continent wide).

Current modus operandi is to have MoU with National Hydrological and Meteorological Services (NHMS), with agreement to share data with TAHMO. TAHMO ideally will pay for all costs and share data with corporate sponsors (e.g. Swiss Re, Montsanto etc), who cover operating costs. However, MoU allows a veto for NHMS of sharing data with particular sponsors – the details of this would need to be clarified. TAHMO therefore act as intermediary/marketing agent negotiating deals for the market segment. In order for TAHMO to provide stations in Zimbabwe, the following will be needed:

- Permision from a local authority, typically an MoU with the Met agency, but it can also come from education, environment etc.;
- A local network of people who will be able to host the stations, typically installed primarily in government locations (next to manual weather stations, at experiment stations, etc.) or at schools;
- A person/people who can look after the country network, e.g. MSD, and who are payed on a performance basis: if the stations work >95% of the time, they get a bonus, >90% of the time, standard payment; 80-90%, 25% less payment. This can put extra finance into the hands of the Met service.

[414] http://tahmo.org/

## Appendix 19.: Technological approach to SMS dissemination

Whilst ESOKO was used in the SWCCIDS project, it was recognised that Frontline/ODK open source tools are available at little cost (only the costs of SMS and associated equipment). ESOKO has the advantage of being a prebuilt system which can work quickly, only requiring assistance with training on its use etc. In the end, it comes down to cost and sustainability. In principal Frontline/ODK should work just as well but requires technical assistance and support to get it going. The SWCCIDS evaluation leans towards Frontline/ODK as a system for the future because of the above considerations, but also that the ESOKO system was administered by Oxfam, whereas for sustainability the system will need administrating by GoZ. Given that both MSD and AGRITEX will require access to a system each for different purposes (one for disseminating weather information and the other for disseminating agricultural advisories), Frontline/ODK may be more suitable. This would also provide additional flexibility for MSD to collect weather station data via the same system. In this regard it is worth noting that messages transmitted during the SWCCIDS project conveyed weather information and not agricultural advisories; some farmers could not understand what 10 mm rainfall meant and so the recommendation was to have separate agricultural and weather advisories – farmers can choose and understand whichever they can. A further important consideration is to use local languages for messages (see Figure A13 below as an example).

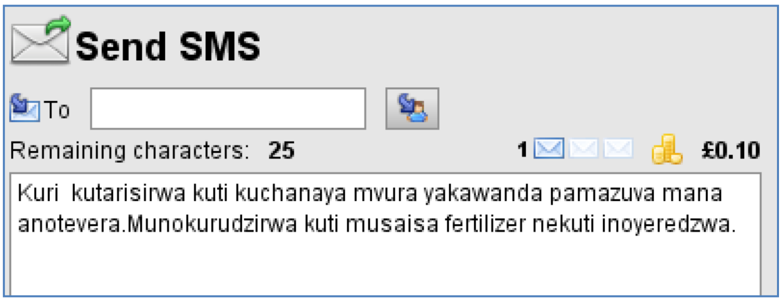



Figure A13: Development of actionable advisories from Met products. ***English:*** *MSD predicts heavy rain in the next 4 days. Agritex encourages you to postpone fertilizer application as it may be leached or washed away*

Having AGRITEX disseminate the agricultural advisories is ideal as it is within their mandate and this is a role for which they have staff and extension workers within farming communities. For this reason, AGRITEX should be involved at the planning stage and the distinction between actions at the national and district levels clearly made i.e. which institutions are responsible for forecast production (MSD) and tailoring (MSD and AGRITEX) at the national level, and dissemination/interpretation (AGRITEX) at the district level. MSD is best placed to undertake information collection i.e. collecting information from weather stations, whereas AGRITEX is best placed to undertake information dissemination (if properly trained) as they have people in all wards (MSD do not have people on the ground). In both cases, University of Zimbabwe can provide technical support. Given the above considerations, the Oxfam UNDP/GEF project is building the data dissemination system described in Figure A14 below, which this proposed project can/should build on.

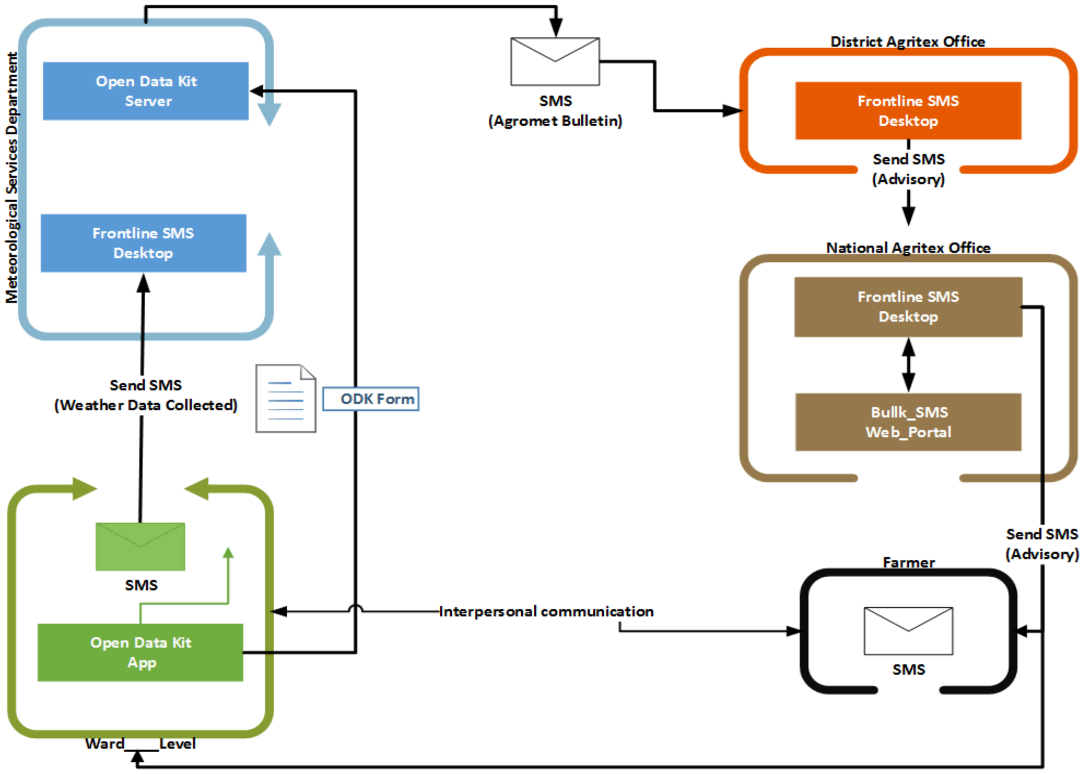



Figure A14: Climate information dissemination system under the Oxfam – UNDP/GEF SCCF2 project

The impact of radio broadcasts and its use was also evaluated. Radio has however distinct disadvantages: i) a farmer can't keep the advisory and show/discuss with others later; b) the farmer needs to be tuned in at a particular time; c) some farmers do not have radios and some places don't have signal; d) the granularity is higher – forecasts tend to be at the district/national level, whereas SMS can provide ward-level advisories. Farmers appreciate having higher resolution information as they believe it to be better/more accurate, highlighting the need to educate farmers on the limits of weather/climate forecasts.

**Costs of running the ESOKO platform**

The cost of sending each SMS on the Esoko platform was $0.02, with the amount only being deducted from the balance once the message had been delivered. This cost was cheaper when compared the other options which were explored which typical ranged from $0.03 to $0.04 per SMS. The following table (A21) outlines the costs for use of the Esoko platform over the course of the SWCCIDS project:

Table A21: Cost of Esoko Platform

| Description | Unit Cost | Quantity | Total |
|---|---|---|---|
| Monthly Subscription | US$100.00 | 6 | US$600.00 |
| Network Manager Training | US$500.00 | 1 | US$500.00 |
| Training and Support (per annum) | US$500.00 | 1 | US$500.00 |
| SMS Messages | US$0.02 | 144000 | US$2880.00 |
| Profiling and Uploading | US$0.10 | 600 | US$60.00 |
| Additional Market | US$500.00 | 1 | US$500.00 |
| Subtotal | | | US$5040.00 |
| VAT (15%) | | | US$756.00 |
| | | | US$5796.00 |
| Additional Subscription | US$100.00 | 7 | US$700.00 |
| Total Cost | | | US$6496.00 |

*Source: Mubatsiri, 2016*

*Esoko Statistics*

The table below shows various statistics associated with the information dissemination component of the project and the use of the Esoko platform:

Table A22: Statistics relating to messages sent using the Esoko platform

| | |
|---|---|
| Total Messages Sent | 37240 |
| Total Failed Messages | 909 |
| Total SMSs Sent | 133632 |
| Total Advisories Sent | 53 |
| Starting Date | 19 February 2014 09:28:53 |
| End Date | 23 March 2015 14:31:59 |
| Recipients at start of programme | 544 |
| Recipients at end of programme | 922 |
| Messages sent in English | 33 |
| Messages sent in Shona | 20 |

*Source: Mubatsiri, 2016*

*Monthly Cost per Farmer*

Using the information presented above, we are able to calculate the cost per farmer of delivering weather information via SMS using the Esoko platform. The number of farmers receiving weather information increased steadily during the project, however to simplify the calculation, we shall use the number of recipients at the end of the programme. We will also remove one- time costs associated with the platform in order to give a clearer indication of the potential ongoing cost of running this platform. This includes the one time training cost of $500, as well as the one time profiling and uploading fee for building up the initial database. The charge for additional market was also removed as this corresponded to the platforms ability to collect and distribute market prices, which was not used in the project.

Table A23: Calculations for average monthly cost per farmer

| | |
|---|---|
| Total cost of Esoko platform (less one-time costs) | US$4896.00 |
| Total number of recipients (end of project) | 922 |
| Average total cost per farmer | US$5.31 |
| Average monthly cost per farmer (13 months) | US$0.41 |

*Source: Mubatsiri, 2016*

*Cost per Message*

We are also able to calculate the average cost of sending out one SMS message on the Esoko platform.

Table A24: Calculations for average cost per SMS

| | |
|---|---|
| Total cost of Esoko platform (less one-time costs) | US$5396.00 |
| Total number of SMS sent | 133632 |
| Average cost per SMS | US$0.04 |

*Source: Mubatsiri, 2016*

## Appendix 20.: Typical purchase costs of hydro-met equipment

**Typical purchase costs for Hydromet equipment**

Table A25: Typical purchase costs for different types of Meteorological stations:

| Station | Purchase Cost | Annual Costs of Operating & Maintenance for each station |
|---|---|---|
| Manual | US$5 000 | US$500 |
| Synoptic | US$30 000 | US$1000 |
| Agromet | US$10 000 | US$700 |

Table A26: Purchase costs for hydro equipment per location:

| Name | Location of hydro station | Type of investment | Estimated cost excl. installation |
|---|---|---|---|
| 1 | Upper sub-catchment for irrigation schemes: Tshingababili + Bambanani. | New station | 40000 |
| 2 | Upper sub-catchment for Tshatshani, Mbebeswana, Tomasi. | Rehabilitation of existing station | 15000 |
| 3 | Upstream Mambale | New station | 40000 |
| 4 | Around Pelele, Guyu-Chelsea. Upstream Mankoninkoni & Sebasa | Rehabilitation of existing station | 15000 |
| 5 | Upper catchment for Zvinyarikwe Muhzwi, Bwanya, Diso irrigation schemes | Rehabilitation of existing station | 15000 |
| 6 | Upstream Malikango | New station | 40000 |
| 7 | Upstream Mwerihari, Murambinda, Nerutanga | New station | 40000 |
| 8 | Inflow to Matezva | New station | 40000 |
| 9 | Sub-catchment inflow to the Save | New station | 40000 |
| 10 | Inflow to Musirizwi, Rimbi | Rehabilitation of existing station | 25000 |
| | **Total** | | **310000** |

Table A27: Typical purchase costs for hydrological equipment

| Item | Quantity | Unit Cost | Total Cost |
|---|---|---|---|
| Ecolog _500 | 10 | $2,390.00 | $ 23,900.00 |
| Vented Cable | 10 | $ 400.00 | $ 4,000.00 |
| Antenae | 10 | $ 145.00 | $ 1,450.00 |
| Irda Link | 5 | $ 440.00 | $ 2,200.00 |
| Shipping | 1 | $1,500.00 | $ 1,500.00 |
| Subtotal | | | $ 33,050.00 |

## Appendix 21.: Climate information courses and related initiatives

Climate information courses and related initiatives, which are provided by Universities are key resources to enable recommended approaches

*Water resource modelling*
UoZ Department of Civil Engineering undertakes a masters course in Water Resource Modelling. This course provides training on how to use models to predict systems performance under unknown future scenarios, focussing on managing uncertainty of water in situations where there is insufficient information and the need to predict and decide on management approaches to be taken for future events. The course covers the development of hydrologic and water management models as the direct outcome of the need to integrate knowledge on existing theories on real world flow behaviour with physical and measured data. This course provides the opportunity to train ZinWA water engineers and hydrologists in the use of Water Resource Models. Given the opportunity to design thesis projects around real world problems, it makes sense for any hydrologists sent on this programme to undertake projects and development of models to service the needs of ZinWA and GoZ in utilising available observations and forecasts from MSD. These students, in partnership with ZinWA and MSD colleagues, could help undertake some of the development work needed to utilise these models, continuing with the work after finishing the course and returning to ZinWA.

*Flood risk assessment*
UoZ (Department of Geography) has undertaken a flood risk mapping of Zimbabwe utilising a flood risk model based on topography at a resolution of 0.81 ha. Risk information is provided as are the thresholds for classifying different levels of risk, depending on the height above the channel and the return period for flooding. This risk mapping provides a useful resource against which the siting of new irrigation schemes and risks can be gauged i.e. for each scheme it is important to assess the likely return period of floods and ensure that risks are minimised and that any irrigation infrastructure is not likely to be washed away.

*Agrometeorology*
UoZ (Department of Physics) has been working with farmers to support their use of seasonal forecasts and knowledge of climate variability and change. In particular they have been working on: i) using indigenous knowledge; ii) basic weather and climate concepts; iii) how to measure rainfall, keep records, calculate start/end of the season, dry spells, rainy days etc; iv) use of agromet advisories; v) training on farmer field schools; vi) training at different levels: district, ward and lead farmers.

## Appendix 22.: Zimbabwe Resilience Building Fund and resilience building approach

The Zimbabwe Resilience Building Fund was setup in 2015 to contribute to increased capacity of communities to protect development gains in the face of recurrent shocks and stresses, enabling them to contribute to the economic development of Zimbabwe. The ZRBF is a multi-donor initiative, supported by the European Union (EU), SIDA and UK's Department for International Development (DFID) and hosted and implemented by Ministry of Lands, Agriculture and Rural Resettlement (MLARR) in management arrangement with UNDP.

ZRBF seeks to ensure that development programmes are designed and based on evidence concerning the shocks and stresses that affect the well-being of rural communities in Zimbabwe, as well as their capacities to withstand and recover from these shocks. In order to analyse vulnerabilities and hazards in Zimbabwe, the ZRBF has collected data on historic and current climate hazards and shocks as well as non-climate risks. Based on this, maps of hazards and vulnerabilities in the country have been produced and used for targeting ZRBF and other UNDP interventions.

The fund has contributed to the development of a strategic resilience framework in 2015. Its work is guided by an approach to resilience that focuses on how to manage natural resources efficiently and sustainably in the face of disturbances and uncertainty, relating to both climate and non-climate factors. The definition of Resilience agreed for Zimbabwe is "*the ability of at risk individuals, households, communities and systems to anticipate, cushion, adapt, bounce back better and move on from the effects of shocks and hazards in a manner that protects livelihoods and recovery gains, and supports sustainable transformation*." (Building Resilience in Zimbabwe: towards a resilience strategic framework, 2015, ZRBF.)

The ZRBF works through 3 main components:

- Component 1: Application of evidence in policy making for resilience increased.
- Component 2: Absorptive, adaptive and transformative capacities of at-risk communities increased and improved. Under call for proposals, the fund disburses money to consortia of civil society, academia, private sector and other partners on a competitive and coordinated basis with a focus on resilience building projects in the most vulnerable areas.
- Component 3: Timely and cost effective response to emergencies rolled out via existing safety net and other relevant programs. The ZRBF Crisis Modifier is linked to early warning systems, so that there is early processing and release of early action funds to limit the negative effects of disaster and preserve development investments in the Funds areas of operation.

Under the call for proposals in 2016, 3 consortia were selected for implementing projects in 9 districts. The interventions are all aimed at achieving increased capacities of communities to withstand shocks and stresses.

- ZVA project: Binga, Kariba, Mbire. 45 wards and 45105 households.
- MELANA project: Nkayi, Nuni, Umzingwane, Umguza. 57 wards, 30989 households.
- ECRAS project: Mwenezi, Chiredzi. 34 wards. 10500 households.

Under the call for proposals in 2017, 4 new consortia were contracted:

- PROGRESS project: Beitbridge, 33 wards and 20,000 households
- Sizimele project: Lupane, Matobo and Insiza, 57 wards and 31,455 households
- ECRIMS project: Zhishavane and Mberengwa, 50 wards and 31,000 households
- BRACT project: Mudzi and Mutoko, 29 wards and 15,505 households

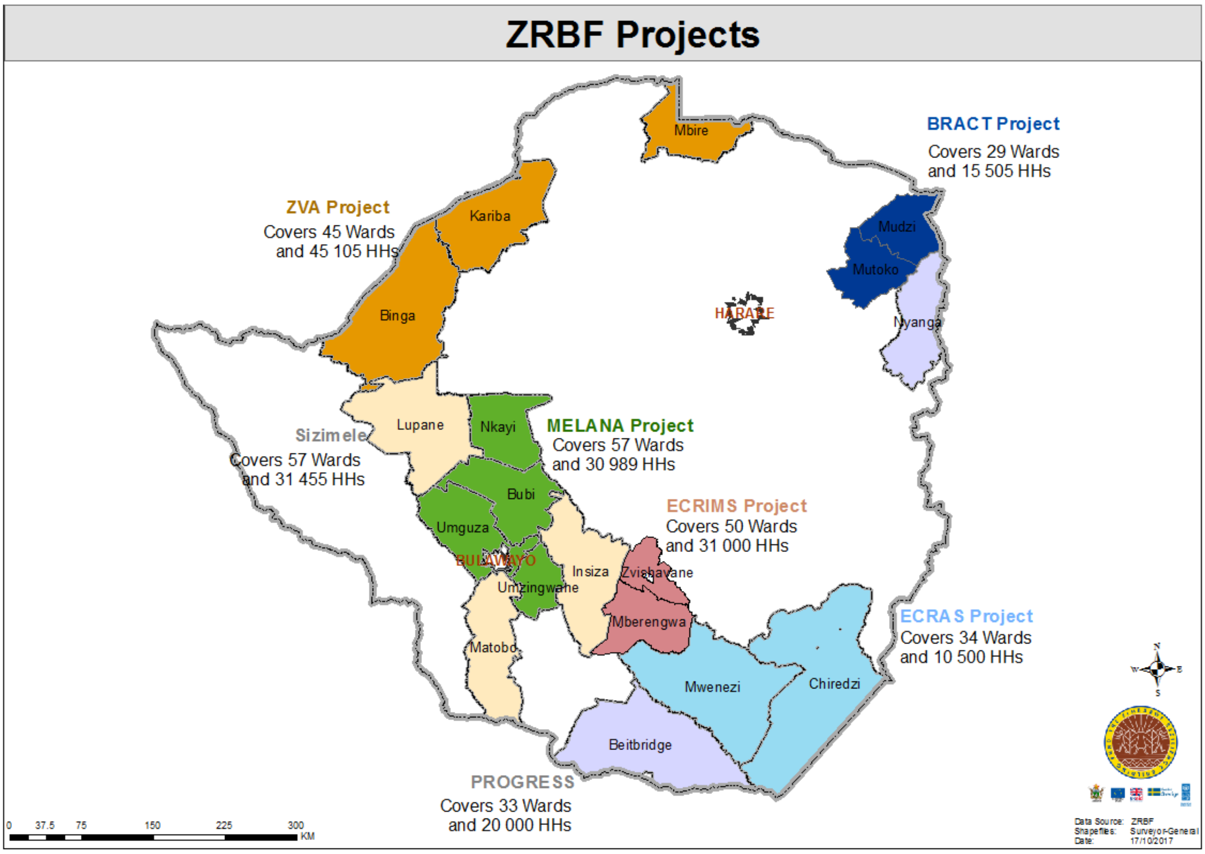



**Figure A15: Distribution of ZRBF Projects**

Most of the interventions implemented under the funds consortia relate to responses to climate change risks and shocks, through climate smart agricultural practices, weather information services and facilitation of market linkages for climate smart crops.

The GCF project will be able to build on investments, good practices and working relationships established by the MELANA, PROGRESS and ECRAS projects as well as good practice from the consortia that have started work in 2017.

The ZRBF has a strong focus on adaptive management and learning and a flexible funding structure that allows for interventions to respond to changing conditions, taking into account a changing climate and a dynamic socio-economic context.

The fund provides a strong national platform for resilience building efforts in the country, bringing together key stakeholders (incl. MLARR and MEWC) and development partners (DFID, EU, SIDA) in resilience building efforts. It is expected that the fund may contribute with strategic investments related to private sector engagement and value chain development, which would be complementary to the GCF investments as part of the proposed project.

## Appendix 23.: Costing of Irrigation Schemes

The irrigation sub assessment provided an overview of the baseline site information to be considered when designing new irrigation schemes and revitalizing existing schemes in southern Zimbabwe. This has been used as a basis for recommending designs and upgrades at each site. The historical performances and lessons learned of existing irrigation schemes have also been considered to ensure that the shortcomings that led to unsatisfactory scheme performance are adequately addressed.

Irrigation schemes are highly case-specific and the diverse conditions of each scheme (climate, water and soil conditions, technology, scheme and plot size, farmer profile, location and access to markets and services) calls for different kinds of climate proofing design interventions to respond to farmers' needs. Adequate infrastructure designs, which are responsive to the changing climatic conditions is key to success of new schemes and the revitalisation of existing schemes should integrate climate proofing measures. The changing climate may also mean that currently functional existing infrastructure is compromised, forcing earlier investment and lower returns for existing investment. Based on the irrigation sub assessment analysis of the various schemes, the following similarities were noted in terms of existing and proposed design options:

- While flood irrigation is currently the most used technology, flood irrigation was not recommended in the targeted, increasingly water scarce environments. The design for infield infrastructure should instead focus on water use efficiency through sprinkler or drip irrigation.
- At many of the target sites, it was evident that much of the infrastructure damage and deterioration was due to flooding, while siltation was prevalent in reducing dam storages. While it is not possible to avoid flooding caused by extreme rainfall events, adaptive design techniques that protect the irrigation infrastructure should be employed.

The designs for revitalising existing schemes and construction of new schemes have therefore focused on water efficient irrigation technologies. The design for flood protection for the proposed schemes work with two methodologies – **above flood level location** and **structure anchoring** with watertight structures where necessary. Appropriate erosion protection has been factored into the design and costings.

To be able to determine the preliminary designs and costings, the schemes were categorised, or 'banded', based on the required pumping infrastructure. Schemes with similar irrigation pump specifications and performance requirements were grouped into the same band. The bands also determined the power requirements and allows for design of power supply requirements.

- The highest common cost driver for irrigation is the pumping gear. The pumping gear requirements are determined from the volume and pumping pressure that gives the pump duty point. While this varies from site to site, it can be banded on the basis of type of motor and pump sets to supply the required water volume to the required pressure.
- The water supply pipelines are computed from the design volume/pressure for water required, resulting in a small range of pipe sizes being required due to the field size limitation.
- The total costs for infield irrigation and supply pipework were determined from unit costs for the conveyance infrastructure.

It should be noted that retrofitting to manage climate change impacts is generally costly. In general, it is less expensive to flood proof a new structure than an existing structure.

The table below documents the banding of irrigation scheme sites according to head and flow requirements.

Table A28: Banding as per head and flow requirements computed per site

| Band | Flow | Head |
|---|---|---|
| Band 1 | 200m3/hr to 540m3/h | Up to 60m |
| Band 1b | 200m3/hr to 540m3/h | Above 60m |
| Band 2 | 540m3/hr to 1080m3/hr | Less than 60m |
| Band 2b | 540m3/hr to 1080m3/hr | Above 60m |
| Band 3 | 1080m3/hr to 1620m3/hr | Less than 60m |
| Band 3b | 1080m3/hr to 1620m3/hr | Above 60m |
| Band 4 | Higher than 1620m3/hr | Up to 60m |
| Band 4b | Higher than 1620m3/hr | Greater than 60m |

Table A29: An example of calculation of costs of revitalising a representative scheme in band 1

| Scheme Name | District | Scheme size | Max land | No. of irrigators | Development Proposal | (M3 Design /hr) Flow | Abstraction Works Including Climate | Conveyance System | Night storage / Balancing | In Field Application (irrigation technology) | Other: Land preparation, erosion control, etc. | Access Road | Scheme Buildings for offices storage and | Scheme security and animal | Total climate proofin | Total typical baseline | Total Capital Cost (US$) | Services: Project preparation & Sustainability Capacity | Percentage climate | Percentage typical | *Comments* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ***BAND 1: Complete Renewal of system equivalent to new (Insert Q,H data for each )*** | | | | | | | | | | | | | | | | | | | | | |
| The costings have been done for Sebasa, because information is available that provides confidence in costings (even though it is not one of the selected schemes). Sebasa is very similar to a lot of the schemes being proposed and designed. | Gwanda | 45 | 65 | 130 | Existing system is not currently functioning. A new system with river bed abstraction through boreholes equipped with electrical driven submersible pumps pumping into night storage dam is proposed. Water to be applied to the field through sprinkler systems. | 162 | Drill Wide BHs/Wells in Tuli River bed Equip submersible pumps Support and headwork structures; provide anchorage | Rising PVC 315mm DN 3km Pipeline with fittings | Brick Tanks of 4000m3 volume | 1x400m span (50) Ha centre pivot or overhead sprinkler system | @$150/Ha | Road grading, minor drainage structures and bush clearing | 100m2 building | $5/m equiv $800/Ha | | | | Hydrogeological study of the proposed boreholes is required to verify adequacy of supply | | | CRIDF estimated costs/ ha for the band - 9250 $/ha |
| | | | | | | | Climate proofing | Climate proofing | Typical baseline costs | Climate proofing | Climate proofing | Typical baseline costs | Typical baseline costs | Typical baseline costs | Climate proofing | Typical baseline costs | | | | | |
| | | | | | | | For Sand abstraction systems maximum extraction 60m3/h to head of 50m requires - 11kW & this is adequate for 8ha @ $30000 ea including borehole. For 65Ha need (65/8)=8 units | 3000m @ $55/m | | | | Sum | @$250/m | | | | | 15 percent | | | |
| | | | | | | | $240,000 | $165,000 | $80,000 | $75,000.00 | $10,000 | $30,000 | $25,000 | $40,000 | $490,000 | $175,000 | $665,000 | | 74% | 26% | |

The capex cost per hectare has been computed to include the preparatory planning, design, procurement and installation of the representative samples of each band of the irrigation schemes. The recurrent annual O&M costs are indicated as a percentage of the full capex value of each scheme. A more detailed overview of costing can be found in the irrigation sub assessment.

The average development cost is estimated to be in the range of $3149 to $11,352 per hectare. The first represents a new scheme with new components from water abstraction to field application and the latter a revitalisation upgrade involving use of sprinkler or pivot systems and climate proofing of the existing infrastructure. The total development cost for approximately 1,786 ha, targeting roughly 5,899 direct beneficiary households, is estimated to cost $14,4 million dollars.

The costs have been categorised as to whether they can be seen as **climate adaptation related incremental costs** or **typical baseline costs** for irrigation schemes with no climate proofing measures. The capital costs of designing and constructing new and existing irrigation schemes to be flood proofed and water use efficient are categorized as climate proofing measures. Costs associated with supply of renewable energy for electricity are considered to be co-beneficial to climate mitigation. Costs involved with fencing of irrigated land, access roads, storage rooms and offices as well as supply of electricity from the grid are considered to be typical baseline costs.

The averaged ratio between climate related incremental costs and baseline costs across irrigation schemes is 78% climate related costs and 22 % baseline costs.

| Estimated costs | Amount | % |
|---|---|---|
| Climate costs | $ 11,199,108.16 | 78% |
| Baseline costs | $ 3,243,391.84 | 22% |
| **Total costs** | **$ 14,442,500.00** | |

## Appendix 24.: Recommended locations of HYDRO-MET stations

As per Appendix 9, Figure 16 shows the current geographic distribution of meteorological stations in Zimbabwe.

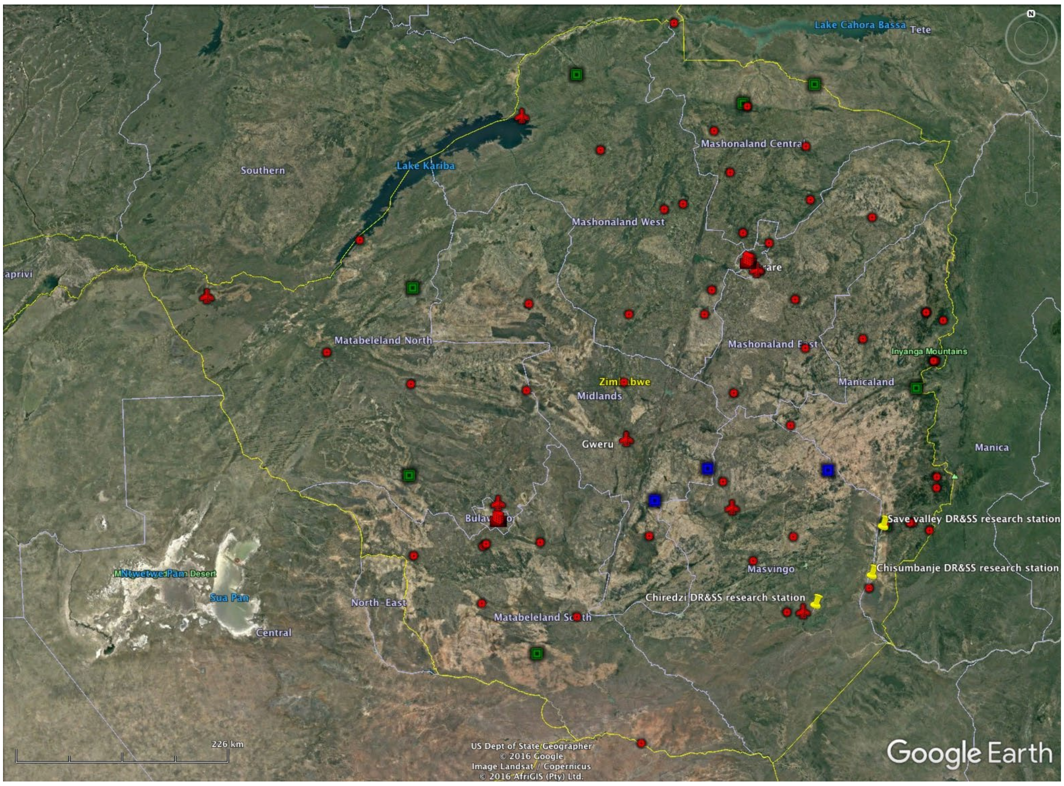



**Figure A16:** Stations in red are manual (airports – airplane, MSD offices – building), green squares are AWS, blue squares AWS through Oxfam UNDP/GEF project, yellow pins AWS at DR&SS research stations (installed by CIMMYT).

The maps below shows the proposed locations for hydro-met stations to increase coverage of the hydro-met observation network for the Southern part of Zimbabwe.

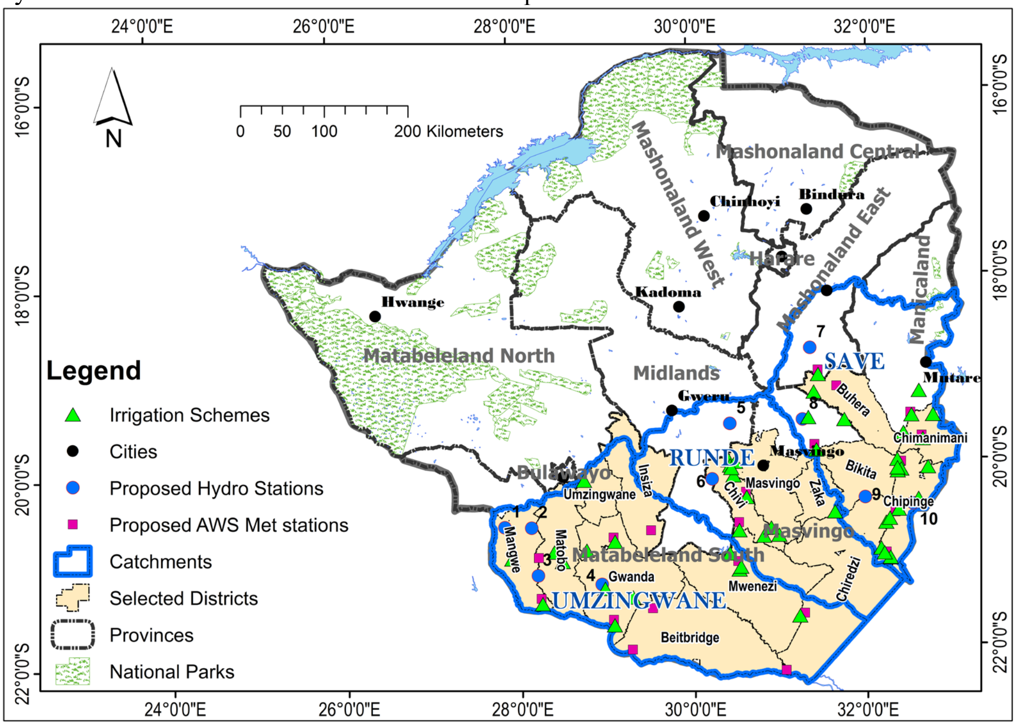



**Figure A17: Locations for hydro-met stations in selected districts**

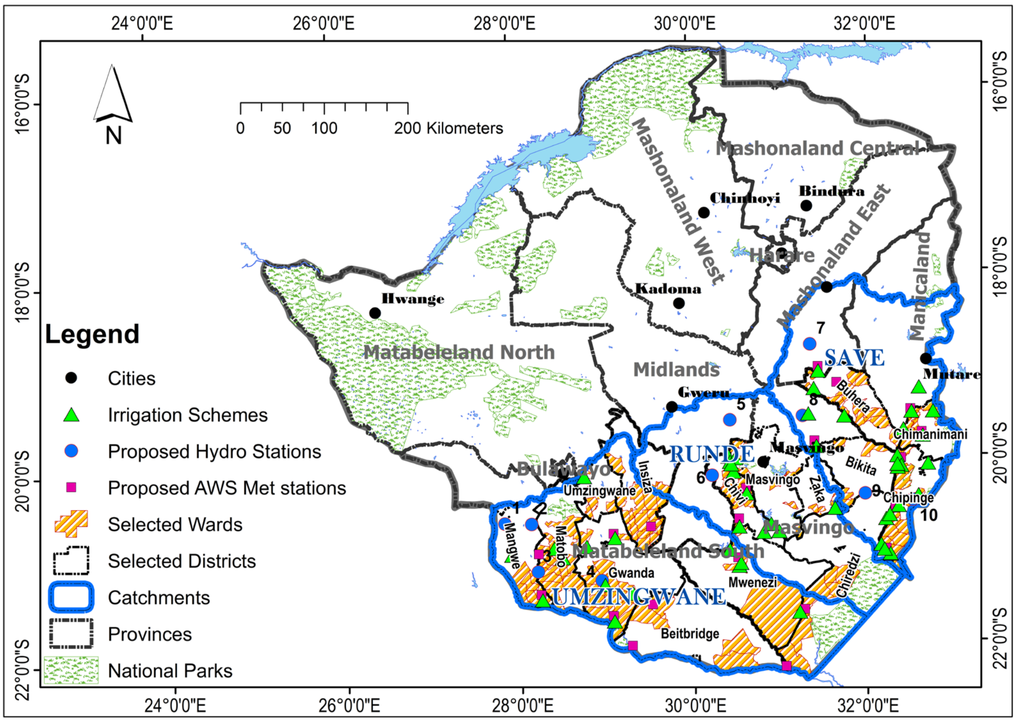



**Figure A18: Locations for hydro-met stations in selected wards**