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Chapter

Climate Change Risks in Horticultural Value Chains: A Case Study from Zimbabwe

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Abstract

Increasing frequency and severity of droughts and floods, shift in onset and cessation of the rainfall and increasing intensity of mid-season dry spells in the last 50 years have been identified in Zimbabwe. This paper presents an assessment of risks from climate change to the horticulture sector of Zimbabwe with the aim to provide mitigatory actions that could alleviate climate change risks in the horticultural sector of Zimbabwe. Specifically the chapter seeks to outline the climate change risks facing the horticulture sector in Zimbabwe, propose actions to reduce risks and assess financing and policy options for climate change adaptation in Zimbabwe. The study followed the approach taken by the International Fund for Agricultural Development (IFAD) which analyses climate risks at each stage of the horticulture value chain. The stages used by Vermeulen are input supplies (seeds, fertilisers, pest management, etc.,); agricultural production (water use, soil management, skill base, etc.,) and postproduction processes (storage, processing, transport, retail, etc.,). Data was collected from multiple stakeholders in areas with notable horticultural production across Zimbabwe using semi-structured interview guides. The study population composed of horticulture farmers, produce processing firms, value chain support organisations and government arms related to horticulture.

Keywords: Climate change risk, Horticulture, value chains, Zimbabwe

1. Introduction

Zimbabwe has a sub-tropical climate with four seasons: cool dry season from mid-May to August; hot dry season from September to mid- November; main rainy season from mid-November to mid-March; and the post rainy season from mid-March to mid-May [1]. The mean monthly temperature varies from 15°C in July to 24°C in November whereas the mean annual temperature varies from 18°C in the Highveld to 23°C in the Lowveld [2]. The lowest minimum temperatures (on average 7°C) are recorded in June or July and the highest maximum temperatures (on average 29°C) are recorded in October [2]. The climate is moderated by altitude with the Eastern Highlands enjoying cooler temperature compared to the low-lying areas of the Lowveld. In their research on agroecological conditions of Zimbabwe, Vincent and Thomas [1] argued that Zimbabwe was generally a semi-arid country with low annual rainfall reliability. The average annual rainfall is 650 mm but geographically it ranges from around 350 to 450 mm per year in

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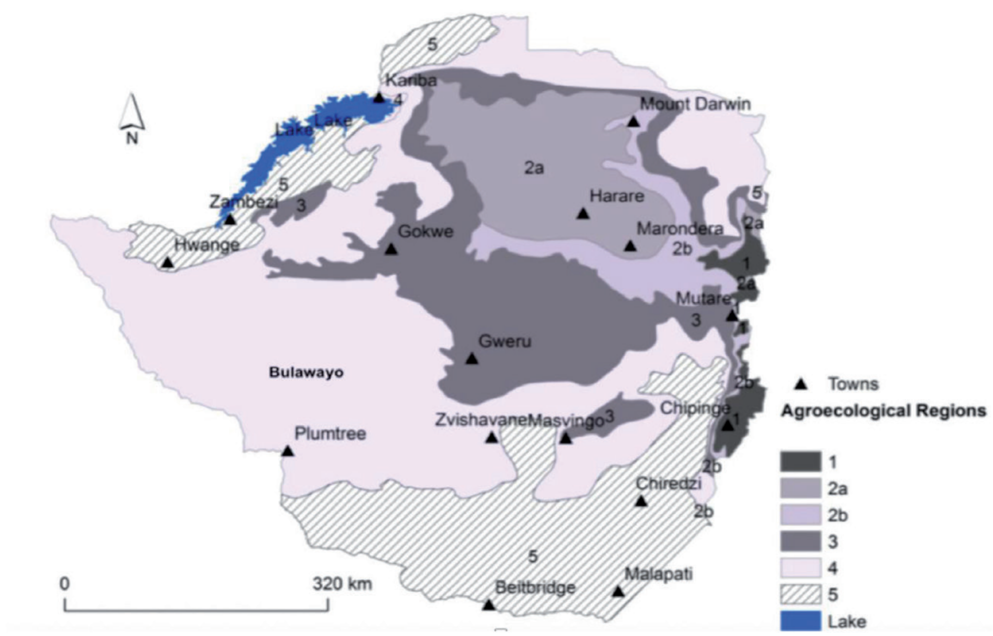
the Southern Lowveld to above 1,000 mm per year in the Eastern Highlands. The rainfall pattern of Zimbabwe is variable with years below and above normal rainfall [1, 3]. **Figure 1** divides the country into five agro-ecological regions on the basis of soil type, rainfall, temperature and other climatic factors. The darker colours are indicative of higher rainfall, better soils and other positive climatic indicators. These regions also represent the agricultural potential for the production of crops and livestock [1, 2, 4]. Region 1 has the highest rainfall, followed by region 2a whose rainfall amounts average the upper limits —1000 mm—of region 2 while those of region 2b average the lower limits —750 mm—of region 2. Region 5 is the most arid agro-ecological region of Zimbabwe and is the second largest agro-ecological region after region 4 (see **Figure 1**). From a climate hazard perspective, the country experiences some relatively frequent drought years which are more frequent in region 4 and 5 (see **Figure 2**).

According to Zimbabwe's Third National Communication on climate change [5], climate change in the country is characterised by high temperature and rainfall variability and extremes. The increasing frequency and severity of droughts and floods, shift in onset and cessation of the rainfall and increasing intensity of mid-season dry spells in the last 50 years have been identified in Zimbabwe's Third National Communication [5] as a major consequence of climate change. The next sections consider the temperature and rainfall changes that have occurred over the years in Zimbabwe. The annual-mean temperature in Zimbabwe has increased



Agro-ecological region	Area covered as a percentage of total national are	Description
1	7000km/ 2%	<1000m rainfall, tea, coffee, plantation farming, macadamia, fruits, intensive livestock production
2a and 2b	58 600km2/ 15%	750-1000mm rainfall, Intensive crop and livestock production
3	72 900km^2 / 19%	650-800mm of rainfall. Severe mid-summer droughts but maize, tobacco, cotton and other cash crops grown
4	147 800km^2/ 38%	650- 800mm of rainfall .Livestock and drought resistant crop production
5	104 400km^2 / 27%	<450mm rainfall supports extensive cattle or game protection

Figure 1.
Agro-ecological regions of Zimbabwe. Source: Chikozi et al. [3].

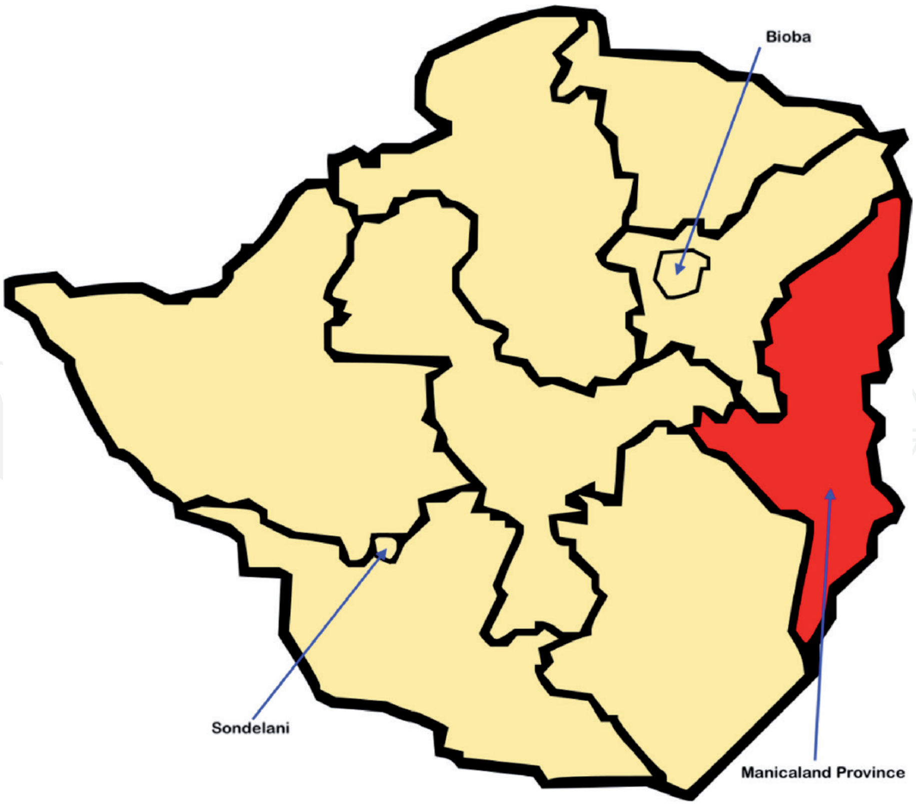


Figure 2.
Study areas.

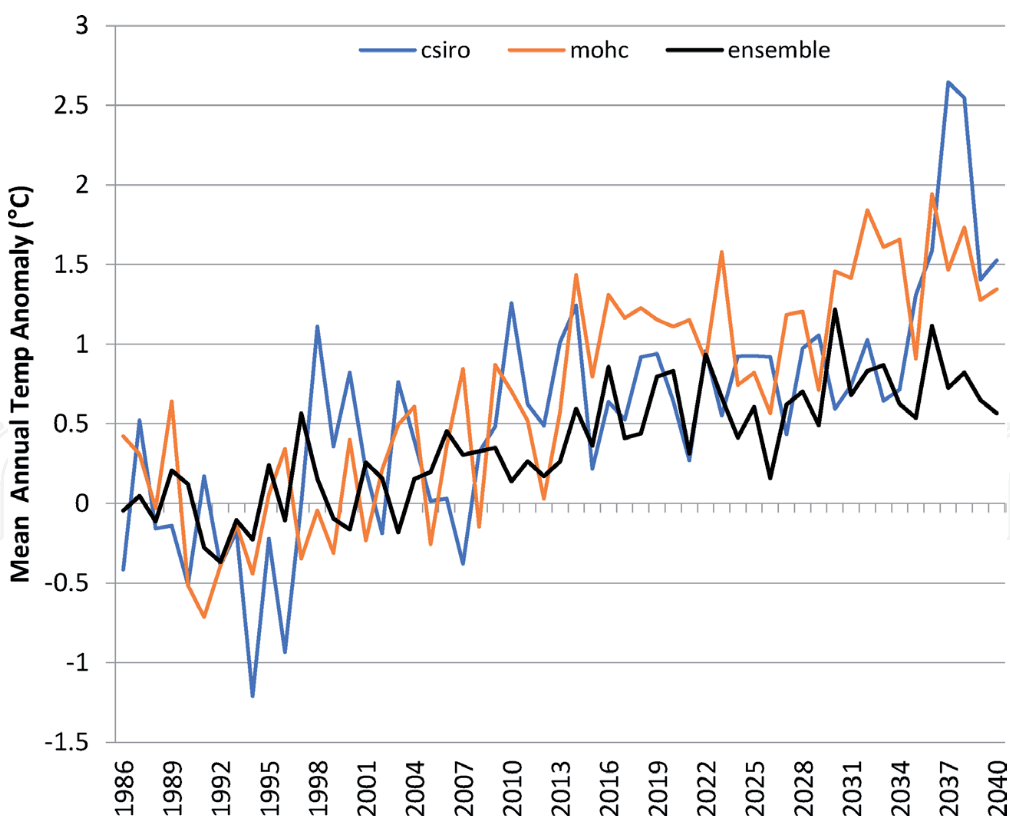


Figure 3.
Predicted mean annual temperature anomalies for Zimbabwe using various forecasting models. Source: Unganai [6].

by about 0.4°C since 1900 [2]. The 1990s decade was the warmest experienced in Zimbabwe during the last century. Between 2000 and 2020 temperatures have also followed and upward trend with the highest average annual temperatures recorded

Region	SoS probability (%) [1]	SoS date [1]	Observed median SoS (1997–2014)	SoS extremes and year observed (1997–2014)	Station used
V	20	31st October	21st November	6th January 2005–2006	Buffalo Range
	40	10th November			
	60	20th November			
	80	25th November			
IV	20	5th November	23rd November	28th December 2012–2013	Plumtree
	40	20th November			
	60	25th November			
	80	5th December			
III	20	25th October	19th November	13th December 2012–2013	Gweru
	40	5th November			
	60	10th November			
	80	25th November			
II	20	25th October	22nd November	19th December 2003–2004	Darwendale
	40	10th November			
	60	10th November			
	80	25th November			
I	20	25th October	22nd November	30th December 2006–2007	Chisengu
	40	5th November			
	60	15 November			
	80	25th November			

Source: Third national communication [5].

Table 1.
Changes in start of growing season.

between 2004 and 2005 (see Figures A2.3, A2.4 and A2.5 in Annex 1). There has been an overall rainfall decline of nearly 5 percent across Zimbabwe during the 20th century with the early 1990s witnessing probably the driest period in the past century [2]. Model experiments suggest that annual rainfall will continue to decrease across Zimbabwe in the future [2] (also see **Figure 3**). Despite the expected rainfall reductions, there have also been substantial periods —the 1920s, 1950s, 1970s— that have been much wetter than average [2].

According to the Third National Communication [5], the Start of Season (SoS) dates for the five representative meteorological stations in each of the agro-ecological zones showed a delayed onset of the rainy season. **Table 1** shows the SoS for representative stations in each agro-ecological zone historically by Vincent and Thomas [1] together with the observed dates for contemporary Zimbabwe. According to **Table 1**, in agro-ecological region V, the rainy season in 1960 was expected to start at the end of October but had shifted to the latter parts of November between 1997 and 2014. The same applies to agro-ecological region 1 where the start of the 1960 rainy season was in late October compared to late November in 2014.

This paper presents an assessment of risks from climate change to the horticulture sector of Zimbabwe with the aim to provide mitigatory actions that could alleviate climate change risks in the horticultural sector of Zimbabwe. Specifically the paper seeks to outline the climate change risks facing the horticulture sector in Zimbabwe, propose actions to reduce risks and assess financing and policy options for climate change adaptation in Zimbabwe.

2. Methodology

The study followed the approach taken by the International Fund for Agricultural Development (IFAD) [7] which analyses climate risks at each stage of the horticulture value chain. The stages used by Vermeulen [7] are input supplies (seeds, fertilisers, pest management, etc.,); agricultural production (water use, soil management, skill base, etc.,) and postproduction processes (storage, processing, transport, retail, etc.,). The methodology included a review of relevant

Large scale horticulture farmers	Small scale farmers	Agro-processors	Support organisations
Makoni farms (flower producers) (1)	Tomato out growers (5)	Schweppes (tomato) (1)	ZimTrade (1)
Chomodzi (sugar snap peas) (1)		Bioba (the African food hunter) (organic indigenous foods) (1)	IFAD (3)
		Nhimbe fresh foods (blueberry, bananas and sugarsnap peas) (1)	HIVOS (1)
		Sodelani (tomatoes) (1)	Palladium (1)
			HDC (1)
			Department of climate change (1)
			DR&SS department (1)
			Technoserve (1)
Total number of respondents: (2)	**Total number of respondents: (5)**	**Total number of respondents: (4)**	**Total number of respondents: (10)**

Table 2.
Representatives of firms and organisations interviewed for the study.

peer reviewed, technical and 'grey' literature on environmental and climate challenges in Zimbabwean agriculture. Examples of such documents include, *inter-alia* the Zimbabwe climate policy (ZCP), national climate change response strategy (NCRS), climate-change national communication documents and preliminary information on the National adaptation plan (NAP). Data was collected from multiple stakeholders in areas with notable horticultural production across Zimbabwe using semi-structured interview guides. The study population composed of horticulture farmers, produce processing firms, value chain support organisations and government arms related to horticulture. **Table 2** summarises the selected study respondents —total 21 respondents— in accordance with the discussed study categories. All respondents save for Sondelani and Bioba have operations in Manicaland province (see **Figure 1**).

3. Findings: Zimbabwe climate change risk outline

Climate predictions in Zimbabwe related to temperature and precipitation have to be done in light of the possible representative concentration pathways (RCPs)[1]. The climate change information fact sheet on Zimbabwe of (2015) predicts that in 2030 the mean annual temperatures in the country will increase by 0.46°C, 1.04°C, and 1.83°C for the 10th, 50th, and 90th percentiles for the RCP4.5. Similarly, the 10th, 50th, and 90th percentiles for the RCP8.5 will witness increases of 0.62°C, 1.25°C, and 1.83°C. In 2050 the climate change information fact sheet for Zimbabwe predicts that the mean annual temperature in the country will increase by 0.95°C, 1.68°C, and 2.66°C for the 10th, 50th, and 90th percentiles for the RCP4.5. Similarly, the 10th, 50th, and 90th percentiles for the RCP8.5 will witness increases of 1.43°C, 2.17°C, and 3.13°C. The greatest increases are projected for the months June through to September. Unganai [6] also predicts an overall increase in annual mean temperature anomalies —temperature changes out of tune with the 1986–2005 average—using three different models shown in **Figure 4**.

Unganai [6] goes further in **Figures 3** and **5** showing the likely temperature changes in the country in accordance with the major river catchments. According to **Figures 3** and **5**, at RCP4.5 most of the country —save for the Eastern highlands— will see an increase in temperature anomalies of above 1.41°C while at RCP 8.5 the general rise in temperatures will be more pronounced in the northern than southern part of the country.

Regarding rainfall, the climate change information fact sheet on Zimbabwe of (2015) predicted changes in the scale of the rainfall probability distribution, indicating that extremes on both sides (floods and droughts) may become more frequent in the future. Furthermore, the climate change information fact sheet on Zimbabwe of (2015) projected mid-century decline of groundwater recharge, decrease in soil moisture and annual runoff. Still on future rainfall patterns and

[1] An RCP is a greenhouse gas (GHG) concentration (not emissions) trajectory adopted by the IPCC for its fifth Assessment Report (AR5) in 2014 [8]. Four pathways that describe different climate futures, all of which are considered possible depending on the volume of GHGs emitted in the years to come have been selected for climate modelling and research. The four RCPs are RCP2.6, RCP4.5, RCP6, and RCP8.5 and all are consistent with a wide range of possible changes in future GHG emissions. RCP 2.6 assumes that global annual GHG emissions —measured in CO-equivalents— peak between 2010 and 2020, with emissions declining substantially thereafter. Emissions in RCP 4.5 peak around 2040, then decline. In RCP 6, emissions peak around 2080, then decline. In RCP 8.5, emissions continue to rise throughout the 21st century.

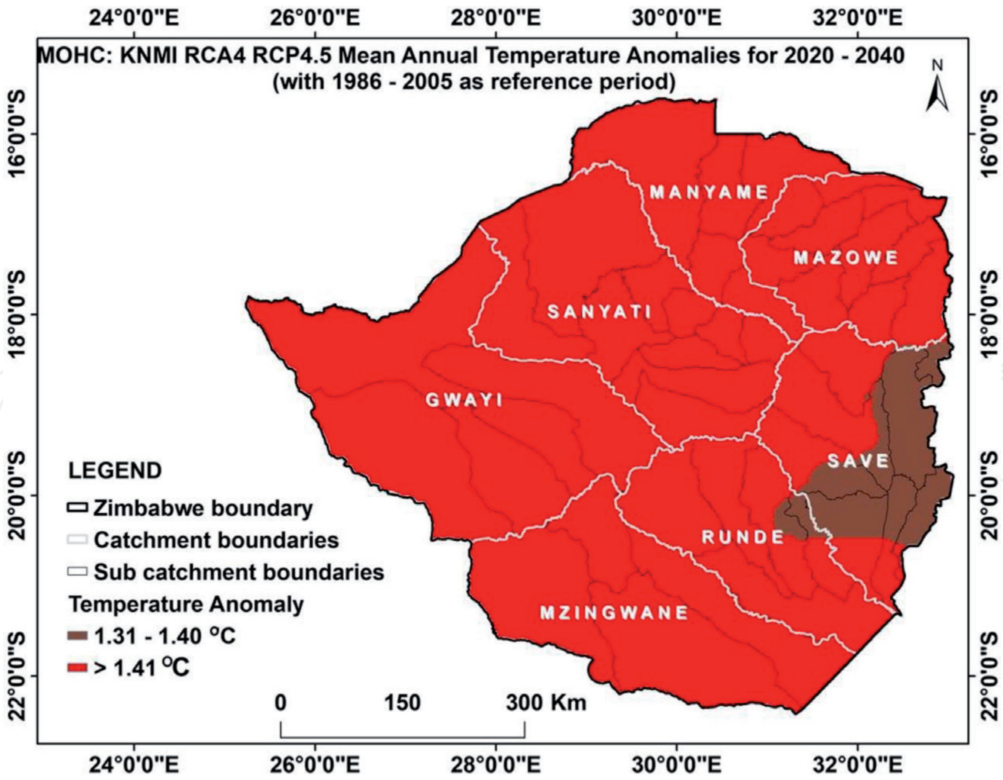


Figure 4.
Predicted mean annual temperature anomalies for Zimbabwe using various forecasting models. Source: Unganai [6].

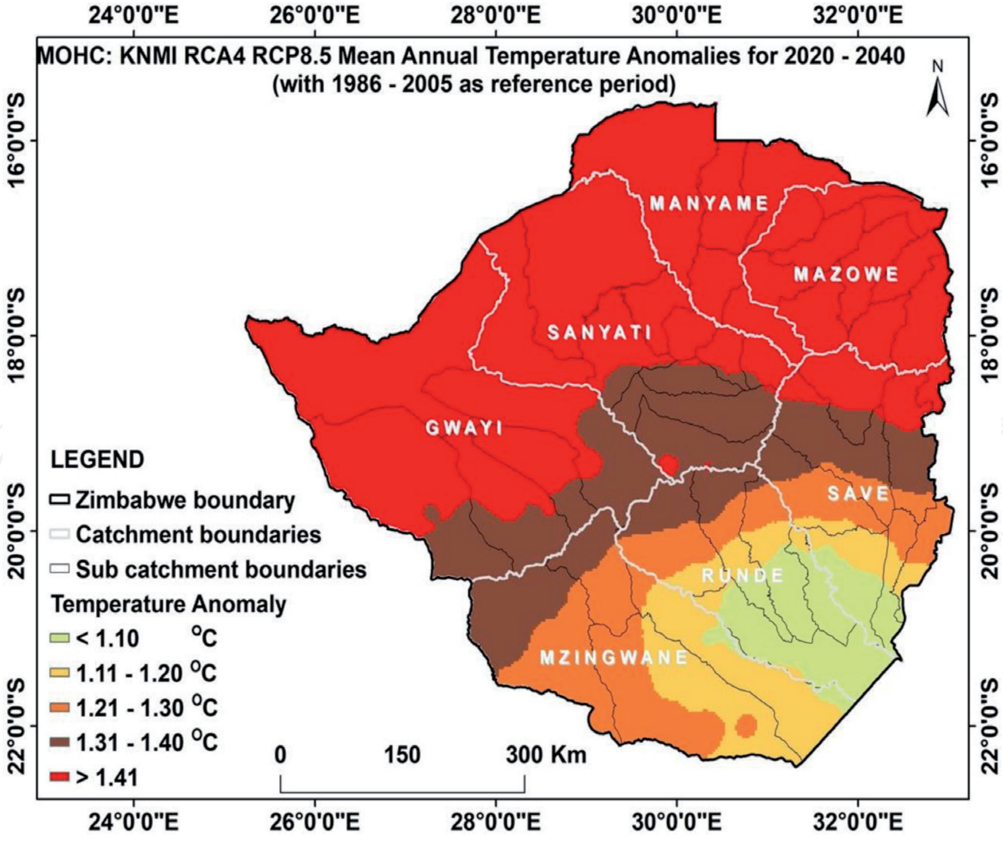


Figure 5.
Temperature predictions for Zimbabwe at RCP 4.5. Source: Unganai [6].

using 1985–2005 as a benchmark, Unganai [6] predicted rainfall reductions in most of the country under the RCP 4.5 (see **Figure 6**) and rainfall increases in most of Zimbabwe under the RCP 8.5 (see **Figure 7**).

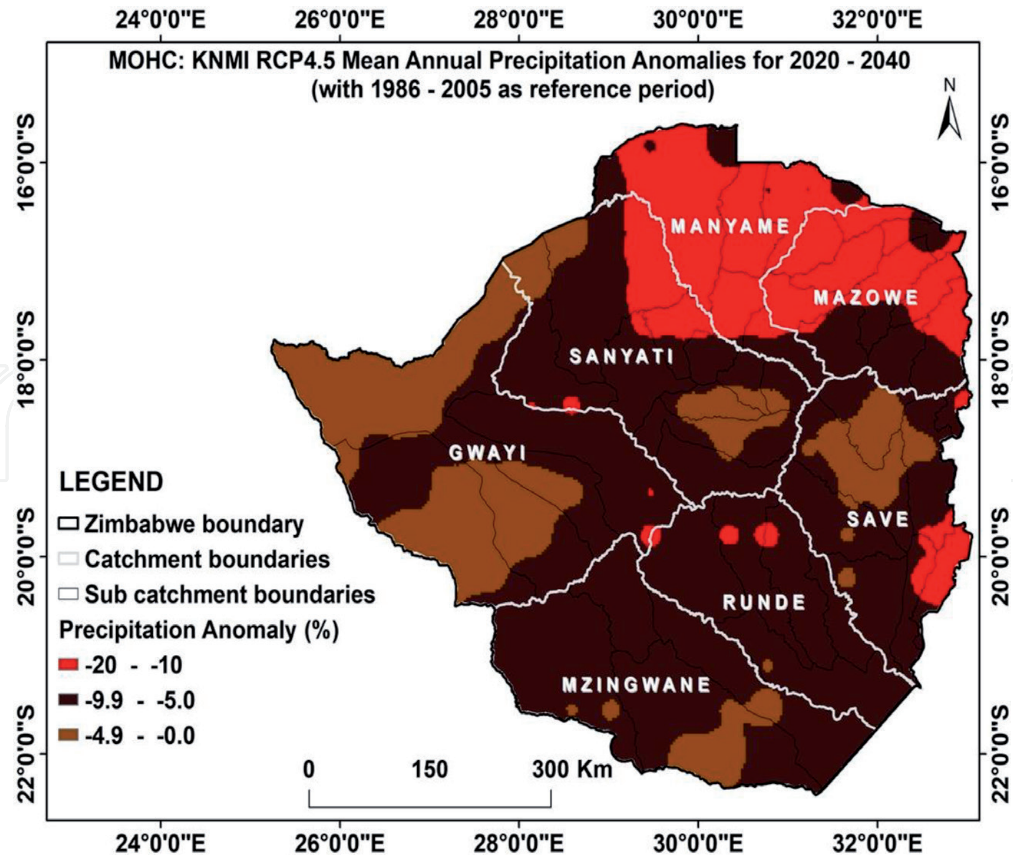


Figure 6.
Precipitation predictions for Zimbabwe under RCP 4.5. Source: Unganai [6].

3.1 Water availability

Zimbabwe is a dry country with limited wetlands[2]. Water can be accessed from direct river abstractions or through storage works. The country also boasts groundwater reserves which have been grouped into 10 hydro-geological units which yield approximately 1.8×10^6 megalitres from registered and monitored uses [5]. Additional water can be obtained through recycling which mostly takes place in urban centres where, potentially, wastewater can be treated to sufficient standards for discharge into public river systems.

Agriculture uses most of Zimbabwe's water that is 81 per cent for irrigation, fish farming and livestock watering. The urban and industrial sectors uses 15 per cent of available water, while mining accounts for 2 per cent of the water [9]. According to the National Climate Policy (NCP) [10], key challenges in water availability for agriculture under the changing climatic scenarios are rooted in three major issues

- Absence of irrigation systems and associated technical capacity,
- Absence of, drought tolerant, high yield, high nutrient, water efficient crops and heat / drought tolerant livestock breeds and
- Failure to manage episodic floods and excess rainfall.

The three major issues point to the need for effective harvesting and management of water resources in order to sustain agriculture in the presence of variable

[2] Zimbabwe's long-term average annual surface run-off is estimated to be 23.7 x 10 megalitres. The distribution of average runoff varies from 21 mm per year in the Gwayi catchment to 126 millimetres per year in the Mazowe and parts of the Save catchment [5].

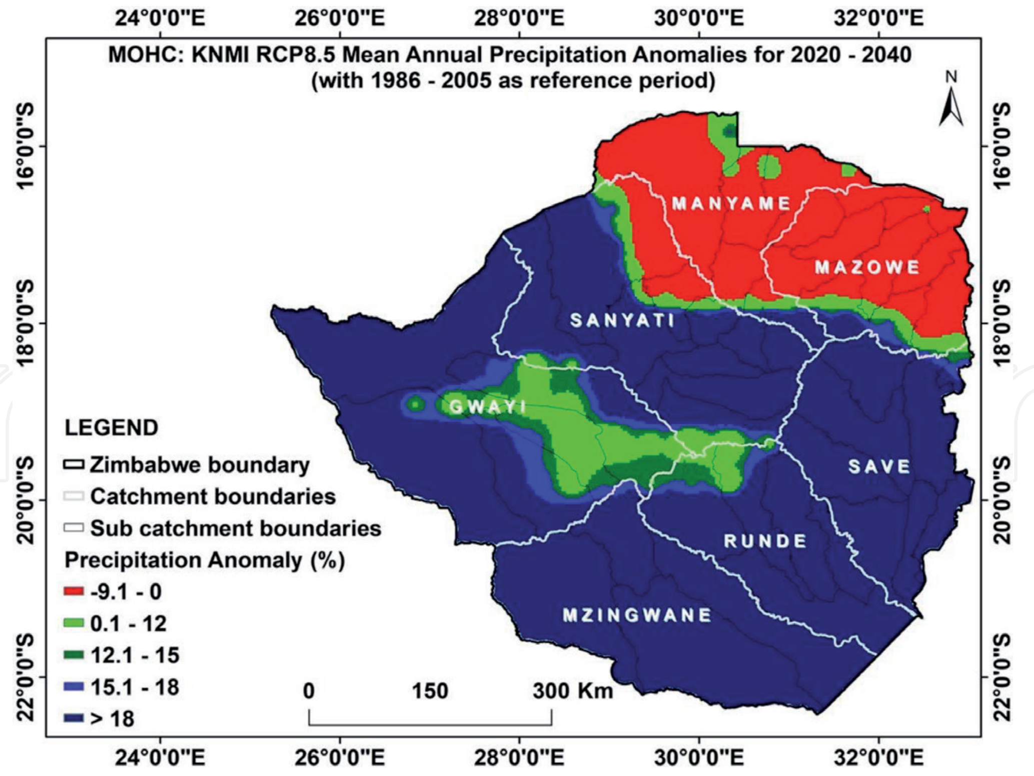


Figure 7.
Precipitation predictions for Zimbabwe under RCP 8.5. Source: Unganai [6].

rainfall and extreme temperatures. Nonetheless, Zimbabwe has the most dams in the Southern African Development Community (SADC) region after South Africa. The country has almost 40 medium-to-large dams and lakes including Lake Kariba as well as about 10,200 small dams. In 2001, about 152,000 hectares of land were under formal irrigation with a total of a further 600,000 hectares of land nationwide that can be made available for irrigation development [2].

3.2 Sectoral and development impacts

Zimbabwe is particularly vulnerable to climate change due to its heavy dependence on rainfed agriculture and climate sensitive resources such as hydro-electric power, wildlife tourism and other ecosystem goods and services. Zimbabwe has an agriculture-based economy with the sector contributing about 15 per cent each year to the GDP [11]. As a result of this linkage, climate is a major driving factor for most of Zimbabwe's socio-economic activities such that Zimbabwe's Gross Domestic Product (GDP) is tightly linked to rainfall patterns [9]. Robertson [12] further illustrated this point showing that in the years when Zimbabwe experienced droughts economic growth levels also declined (see **Figure 8**[3]).

Livelihoods of the poor, particularly women[4] who are highly dependent on climate sensitive sectors like agriculture, are likely to be impacted by climate change in various ways. Climate change impacts are also expected to disproportionately affect the young, elderly, sick, and otherwise marginalised populations who may not have the necessary livelihood capital assets —natural, financial, physical, human and social—to allow for adaptation or recovery when climate disasters strike.

[3] All years with red columns were drought years while those with orange columns were years of the fast track land reform programme. Blue years are considered normal years.

[4] Rural women had gender related duties that saw them increase their level of effort due to the negative effects of climate such as drought and extreme temperatures [13, 14].

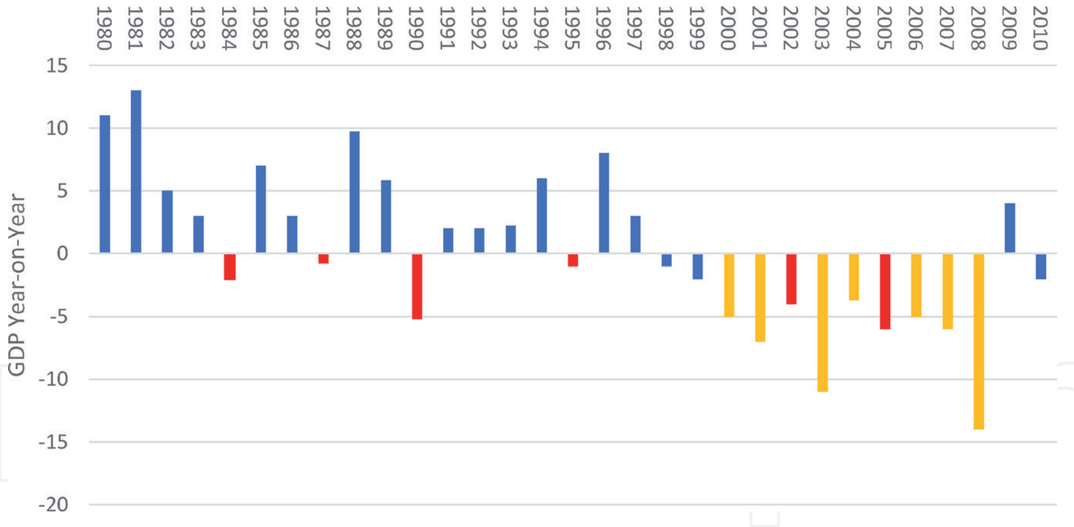


Figure 8.
Relationship between GDP and drought in Zimbabwe. Source: [12].

3.3 Climate risks and horticulture value chains

Zimbabwe's agricultural sector is divided into four major sub-sectors namely; large scale commercial farms, small scale commercial farms, communal and resettlement areas. The agrarian structure has changed with the recent land reform in Zimbabwe with 99 per cent of the farmers now being smallholder farmers (SHF). Of these 81 per cent are communal farmers, 18.7 per cent resettled farmers and 0.1 per cent large scale farmers [11].

Zimbabwe has a diverse horticultural subsector, producing vegetables —for export and domestic sales—, fruits —for export and domestic markets— and flowers —primarily for export—. The major horticultural exports from Zimbabwe are destined mostly to European and other African markets. At its peak in the late 1990s, horticulture was the second largest agricultural foreign exchange earner after tobacco, recording export figures in 1999 of up to US$144 million. Its trade balance however declined significantly over the years, influenced by the dollarization and the previously mentioned land holding changes. This negative trend reversed recently with exports recording significant growth in 2018 —more than $112 million against $50.9 million in 2017— [15]. The sector is also a significant earner of foreign currency thereby improving the country's terms-of-trade in addition to numerous downstream benefits in the packaging, processing, input suppliers and transport industries. According to the ITC [16], there is potential for the horticulture sector in Zimbabwe to contribute significantly to growth due to the following important factors:

a. Proven experience of commercial and SHFs in producing internationally competitive crops,

b. Short gestation period of some of its commodities,

c. Direct social impact on poor farming communities and

d. Creation of decent jobs for both men and women across the value chain.

The UKTP [15] together with Shone [17] noted a number of constraints inhibiting the growth of the sector that may be summarised as follows:

- ***A lack of export diversification***: Zimbabwe is currently exporting on a few products compared to the pre-Land Reform Programme of 2000. It is mainly limited to fresh exports whereas in the past, Zimbabwe was exporting processed fruit (paste, ketchup, juices) and vegetables (fresh cut and dried). This is mainly due to the lack of expertise and infrastructure as some of the exporting companies closed shop.

- ***Low production volumes:*** since the Land reform of 2000, horticulture production for export has significantly gone down as systems that supported production —out-grower schemes, irrigation schemes, greenhouses and pack houses and cold chain transport— have been run down.

- ***Lack of supply chain integration and linkages with UK/EU firms:*** The supply chain is fragmented and the sector is disconnected. Its apex body, the Horticulture Promotion Council (HPC) which was affiliated to the Commercial Farmers Union (CFU) is now defunct. At its peak, the HPC was responsible for facilitating viable export linkages for producers.

3.4 Major risks and possible mitigation

Regarding inputs in the horticulture sector, production works best under drip-irrigation hence drought tolerant seed varieties may not be necessarily applicable in this case. However, seed varieties that are resistant to frost and heatwaves are crucial given the expected cooler winters and higher temperatures in future. Crops may also be prone to pests which will likely increase in the incidence of longer hotter summers. In this regard, the use of tissue culture and the development of varieties that are resistant to temperature extremes is essential for mitigating seed related climate risk. Tissue culture will assist the expansion of horticulture production and build resistance to water shortages, specific pests and temperature extremes.

Soils will require nutrient augmentation and the use of chemical fertilisers can have adverse impacts on agro-biodiversity and can result in eutrophication through erosion in the case of flash floods related to climate change. Use of fertilisers is linked to increased GHG emissions particularly in the case of methane and nitric-oxide. As such, in is critical to improve availability of fertilisers / build capacity for composting and to promote crop rotation to increase soil nutrients. Crops are also susceptible to attacks by pests and viruses. The increase in extreme temperatures can increase the prevalence of certain pests and viruses or reduce that of insects that attack pests. Thus, it is essential to explore organic / agrobiodiversity solutions for specific pests in order to maintain organic production. It is also useful to identify ideal crops for intercropping and integrated pest management.

Regarding information services in Zimbabwe, extension services may be considered as limited in resources. Nonetheless, there is scope for electronic messages on weather trends. Messaging is however limited by weak communication infrastructure and low forecasting capacity. As such, it is useful to strengthen early warning systems —including Geoinformation Science (GIS) and Earth Observation —on cropping season quality, rangelands conditions, droughts, floods, disease/pest outbreaks and wildlife movement; Strengthen capacity to generate new forms of empirical knowledge, technologies and agricultural support services that meet emerging development challenges arising from increased climate change and variability and Strengthen the capacity of farmers, extension agencies, and private agro-service providers to take advantage of current and emerging indigenous and scientific knowledge on stress tolerant crop types and varieties, including landraces that are adaptable to arising climatic scenarios.

In the Zimbabwean horticulture sector, SHFs are often constrained by the lack of adequate technology for production, harvesting, handling and storage. In some cases hostile temperature fluctuations hinder production or storage processes as better technology may be required to deliver the same quality output in the presence of *inter-alia* heatwaves, frost, hailstorms, droughts and floods. The absence of adequate technology for all SHF may open up opportunities in the public and private sector for sharing agricultural equipment using equipment pooling mechanisms that may see the emergence of pool tractors, trucks, ploughs, etc. This is already happening using the VAYA agricultural sharing tools platform. Such a service could be extended by the public sector. It is also necessary to develop appropriate storage which can handle high temperatures and maintain humidity will build resilience in the horticulture sector.

From and agricultural production perspective, the increased temperatures are likely to increase evapotranspiration and potentially salinity as more groundwater is extracted for irrigation purposes. Also, there is potential increased erosion due to long dry spells. Also, the erratic supplies of water rooted in the recurrent droughts have been the major negative effect of climate change. The commencement of the rainy season is often delayed and there is an overbearing need for water harvesting and irrigation if at all the value chain is to be viable. Drip irrigation is used in most of commercial horticulture production as it is more efficient and ideal. In the absence of water reservoirs, horticulture production would be seriously compromised. Given the above, it would be essential to identify latest technology for minimum tillage production models in order to conserve the soil. Also, the promotion of the regeneration of native species in and around growing areas could be encouraged together with water harvesting.

Horticulture tends to be dominated by monoculture. Monoculture leaves crops more vulnerable to pests and diseases as well as speeds up soil degradation. Monoculture also compromises biodiversity conservation efforts as it limits species diversity. In the presence of negative climate changes —e.g. temperatures that promote the breeding of particular pests— the overall ecosystem loses resilience and the risk of total loss of produce increases. Farmers can maximise productivity by selecting appropriate crops to be utilised for intercropping; this will not only provide shade for the soil but also maintain soil health and provide additional income.

From an energy dimension, it is important to note that Zimbabwe's electrical energy comes from hydro and thermal —coal fired power stations—generation mechanisms. The absence of regular dependable rainfall makes hydro-electricity generation a challenge. This in turn pushes the nation to depend on coal fired thermal power which increases GHG emissions. Furthermore, this negatively affects irrigation and other farm activities that require electrical energy given the energy deficit rooted in drought. Dwindling hydro-power potential and increasing emissions in coal fired power stations opens up new avenues in public and private investment in clean renewable energy. As such it is critical to promote and invest in the production of clean energy.

Harvest management often requires the use of complex energy consuming equipment. Previous sections in have already explained the climate risks that limit the access to hydro-power and ultimately energy. Furthermore, deliberations on access to finance also exposed challenges in accessing complex equipment. Furthermore, processing is undertaken by the large off-takers and climate related risk is entirely shouldered by them. Most of this risk is again related to energy availability and processing activities that also require energy. Water availability is also crucial in the processing phase. As such, the recurrent droughts again present risks to the effectiveness of the processing stage. This phase also generates a lot of waste that is often dumped into the natural environment creating negative externalities that are a great ecological cost to society.

Finally, this study exposed a number of climate risk factors to consider in the various horticulture value chain models. A significant number of the risk factors may be countered using the knowledge possessed by the farmers regarding climate change management. In the absence of such knowledge, farmers may fail to deal with the negative aspects of climate change resulting in higher climate risk.

3.5 Horticulture farming models in a changing climate

This section presents the models observed in various horticulture value chains in Zimbabwe with a focus on how the different models manage climate and environmental risk. The two prominent models were a model based on variations of contract farming and a lease-based model.

3.5.1 Contract farming based model

The first variation of the contract farming model was observed under Technoserve —an NGO operating within Zimbabwe—. The model is characterised by a lead firm —Linkflora/Lingfield Farm— working with 100 SHFs in 10 irrigation schemes in the Midlands region of Zimbabwe. This model has a field officer on each irrigation scheme who is responsible for production and the day-to-day running of the horticulture programme. The field officers from the Irrigation Schemes report to a manager who manages all the schemes. It is anticipated that after the programme the SHFs will pool funds and continue to hire the field officers for services which are critical in continued export production.

The second variation of the contract farming based model was observed at Sondelani ranching in the Matabeleland region. Sondelani Ranching is working with over 25,000 SHFs as a lead firm in a tomato contract farming scheme in Matobo district, Matabeleland south province. Sondelani provides inputs to farmers who pay back when they sell their produce to the lead firm. The SHFs are grouped into production capacity groups: the best being Platinum with 13,000 farmers followed by Gold with 13,000 farmers and then Silver with 1,000 farmers. The SHFs produce and feed into the Sondelani tomato processing plant that processes 150 tonnes of tomatoes into puree per day (commissioned by the President Mnangangwa in 2018). Sondelani also works with 2 commercial farms who produce about 10% of their raw produce while 90% comes from SHFs. The tomato puree is sold locally and exported into the SADC region. Sondelani key informants explained that Farmers are trained through a subsidised training programme (training costs 450 and farmers are asked to pay ZW$100 for a 3-day training) run by Sondelani's foundations for farming division. Sondelani has put in place a social capital based safeguard system where members —mostly women— are organised into groups that observe production rules. Any offender is dealt with by the group and has to make amends. Failure to which the group has power to dismiss the member who does not follow the rules. If a farmer sells to other markets they have to make sure repay their loans of inputs to Sondelani on time and in full.

3.5.2 Lease-based model

The alternative to the contract farming based model observed in value chains across Zimbabwe was a lease-based model. Schweppes —a large beverages manufacture in Zimbabwe— is implementing such a model through leasing land —150 hectares for tomato production —from SHFs in Darwendale close to the capital Harare. Schweppes plants tomatoes on 50 hectares at a time and the other 50 hectares are used for the next crop —usually peas—in a crop rotation system.

The 50 hectares that Schweppes does not use each season may be used by SHFs to produce crops of their own choice so long as they are in line with crop rotation of the export crop being produced by Schweppes. In this model, SHFs agree to lease their land to Schweppes on a 5-year basis, receive payment for leasing the land and a share of profit from production of their land. Schweppes has full control of the land use and production while SHFs are offered first refusal of offer to provide labour to Schweppes. Over the 5-year lease period, SHFs benefit from knowledge transfer, management partnerships, learning farming as a business and technical expertise. Other benefits include SHFs receiving constant income generated from working for Schweppes, land leasing, share profit and infrastructure development.

3.6 Development impacts of the models

Research on similar models presented by Scoones [18] at the British-Africa investment summit of 2020 compared three broad types of commercial agricultural investments —estates and plantations, medium-scale commercial farms and out grower schemes— in Ghana, Kenya and Zambia focusing on outcomes for land, labour and livelihoods. The cases included investments with some UK-linked companies, including the Blue Skies company in Ghana, which packages and exports fruit produced by smallholder out growers and an out grower scheme in Zambia, operated by Illovo, now largely owned by British Foods, whereby SHFs' land is incorporated into an estate, and they are paid revenues for the use of land. Scoones [18] concluded that the 'terms of incorporation' into business arrangements really mattered. Too often estates/plantations operated as 'enclaves' separated from the local community, possibly providing employment opportunities, but frequently with poor conditions. Those investments that had substantial linkage effects included those with smallholder-led out grower arrangements, where leverage over terms was effective. Meanwhile, consolidated medium scale farms potentially had positive spill over effects into neighbouring communities through labour, technology and skill sharing linkages. Scoones [18] further argues that private sector investment that has the most impact is usually small, often informal, and deeply linked into local economies. Clusters are usually spontaneous, not planned as part of grand corridor or investment hub schemes.

In relation to this study, perspectives raised by Scoones [18] generally favoured the variations of the contract farming-based models from a development perspective. Scoones' [18] arguments were centred on the yield and livelihood transformation potential of model in question. In addition to that, this study considers the pros and cons of each model —using information gathered from data collected—with respect to climate and environmental risk.

3.7 Environmental impacts of different models

In the lease-based model, the mitigation of climate and environmental risks related to production —e.g. composting, organic production, pest control, etc.,— is highly linked to market requirements and costs of implementing the initiatives. Thus, if the risk mitigation actions are beneficial for the natural environment but not required by the market, they less likely to be implemented. Regarding access to critical climate and environmental risk information, in the agricultural manager and lease-based model, the manager/lead firm are the source and distributers of information sourced at a lower transaction cost due to the centralised organisational structure. This allows the lease-based models to better access climate risk related information services. The same argument applies to climate and environmental risk financing within the agricultural manager and lease-based models. In the lease-based model, climate and environmental risk financing is not much of a challenge as the protagonist —e.g. Schweppes—is well placed to access required financing to deal with climate and environmental risks. The agricultural manager-based model is also similar though could change in a negative direction after the contract between the off-taker and manager lapses given that SHF would have to source their own financing. Regarding climate and environmental risks related to energy, the lease-based model allows for the easy use of alternative —to hydro-electric power—localised electricity generation processes such as solar mini-grids which are most effective and efficient in such centralised systems including the agricultural manager based model.

The contract farming model has better opportunities for mitigating climate and environmental risks related to production. For instance, the use of organic fertilisers may be easier mainstreamed together with minimum tillage principles because of the extensive training— silver, gold and platinum— that the various categories of farmers go through[5]. Also, in the contract farming model, social capital levels are high and the social rules and norms are not always driven by profit thus, may see farmers practicing what was taught even if it took a little more of their time and effort. In the contract farming-based model, farmer disaggregation may increase the transaction cost of accessing reliable and useful information thereby making such a model not as effective in dealing with information related climate and environmental risk. Nonetheless, the central role played by the lead firm —e.g. Sondelani ranching— allows for centralised information sourcing though dissemination of the information may be less efficient —due to the disaggregated nature of individual contract farmers— in comparison to the compact lease model. In the contract farming model, the access to financing may not always be extended to the disaggregated smallholder farmers as the risk of loan defaults changes with each SHF in question. Also, In the contract farming model, the decentralised nature of SHFs exacerbates the energy problem and makes a centralised solar PV system difficult to set up. This model therefore leaves the challenging issues related to energy in the domicile of the SHF who in most cases does not have adequate resources to make the investment required to avoid climate risks related to energy.

In all the models the large off-takers have the ability to develop suitable packaging for increasingly high temperatures, humidity and precipitation while maintaining food safety standards. The quality of the packaging however is likely to be a function of market preferences rather than environmental considerations given that the primary objective of the off-taker is like to be profit maximisation.

4. Climate policy and financing in Zimbabwe

There are a number of national policies in Zimbabwe that focus on climate and the broader environment. Zimbabwe has a National Climate Response Strategy (NCRS) supporting the National Climate Policy while consultations on the development of National Adaptation Plan (NAP) are on-going. The country has also submitted its Nationally Determined Contributions (NDCs) to the UNFCCC.

The National Climate Change Response Strategy provides a framework for a comprehensive and strategic approach on aspects of adaptation, mitigation, technology, financing, public education and awareness. It will help to inform Government on how to strengthen the climate and disaster risk management policies.

[5] Such training may not be as intensive in the lease based model given that the large firm already brings in the technical expertise.

The Zimbabwe National Climate Policy explains that Zimbabwe seeks to create a pathway towards a climate resilient and low carbon development economy in which "the people have enough adaptive capacity and continue to develop in harmony with the environment". To achieve this, the Climate Policy is supported by the National Climate Change Response Strategy, National Adaptation Plan, the Low Carbon Development Strategy, National Environmental Policy and Strategic Document as well as other policies aimed at achieving sustainable development. The actions envisioned in the Policy will "safeguard the Zimbabwean natural environment, sustain society, and support the economy for the years ahead". "Adequate financing, cross sectoral coordination, climate change science, research and systematic observations will form the backbone of actions towards a climate resilient Zimbabwe" (NCP, 2016:2).

It is the vision in the National climate policy to "climate-proof" all the socio-economic development sectors of Zimbabwe in order to reduce Zimbabwe's vulnerability to climate and climate related disasters, while at the same time developing along a low carbon pathway (NCP, 2016:2). Zimbabwe aims to reduce per capita emissions by 33% from "business-as-usual" baselines by 2030 (NCP, 2016:4). This ambition is based on the availability of financial resources and technology transfer from bilateral and multilateral funding mechanisms in addition to domestic financing.

4.1 Costs of climate change financing

The Development Bank of Southern Africa estimate the costs of climate change adaptation to be US$9.9 billion. The costs to agriculture are almost US$2.4billion [2]. Evidently, the climate risk mitigation and adaptation options discussed in the previous section require financial and technical resources to come to fruition. The potential sources of finance within and outside Zimbabwe are discussed below.

The Zimbabwean agro-food sector has undergone major changes ever since the fast-track land reform programme (FTLRP). These changes influenced new models of production, marketing and financing [19]. Access to external financial capital for the majority of participants remains limited. If available it is costly and inequitably distributed thus, severely limiting the productivity and competitiveness of the majority rural SHFs [20–22].

The changing agricultural environment in Zimbabwe has come with a drought of the typical financial products and services for agricultural production that were previously designed for large scale commercial farmers [23]. According to Sachikonye [24], financial intermediaries lack depth and understanding of the rural SHFs who in most cases have non-liquid assets that are not recognised by conventional financial markets. As such, conventional thinking is that the agricultural sector (particularly the SHF) is too costly and risky for lending [24–26].

Biyam [23] notes that commercial banks have traditionally shied away from the rural smallholder agricultural sector because of uncontrollable and systemic risks, higher costs and fear of the unknown. The cost of directly lending to rural smallholder farmers in hard-to-reach rural areas with less-educated and low-income populations has become prohibitive to most formal financial institutions [25, 27]. Microfinance institutions that loan cash to these low-income households do so at a high cost, with short-term loan products that are generally not able to address the full range of agricultural needs of the rural SHFs [25].

4.1.1 Financing for SHF and related stakeholders outside Zimbabwe

The most important multilateral sources of climate financing at the international level are the World Bank's carbon funds, the Global Environment Facility

(GEF)—recently supported the development of the Zimbabwe NAP—, the African Development Bank (AfDB), African Sustainable Forestry Fund, the United Nations Framework Convention on Climate Change (UNFCCC's) Adaptation Fund, the Green Climate Fund (GCF)—which is a financial mechanism of the UNFCCC—and the Kyoto Protocol's Clean Development Mechanism.

Pswarayi-Jabson [28] noted that there is limited funding that private entrepreneurs and CSOs can access in the global climate management mostly because most of these organisations tend to compete rather than work together to access such financial resources. Local private organisations and CSOs in Zimbabwe are often prevented from accessing climate funds directly due to the large size of available grants, donor partner preference and the absence of an enhanced direct access mechanism [28]. The above is mostly because Zimbabwe currently does not have institutions accredited as a National Implementing Entity, so as to access direct to the GCF. However, efforts are being made to have the Environmental Management Agency (EMA) and the Infrastructure Development Bank of Zimbabwe (IDBZ) accredited with the GCF as implementing entities. Such accreditation would deal with access to finance challenges such as failure to meet global fiduciary standards; misalignment of financing application with other institutional arrangements and requirements of climate funding such as the GCF, GEF and IFC/World Bank and lack of expertise in packaging of green projects, with particular focus on mainstreaming of climate issues. Nonetheless, the NCRS [2] notes that Zimbabwe has received modest funding from, for example, multilateral organisations (such as UNDP, UNICEF, UNEP; GEF; GEF Small Grants Programme and FAO); international organisations (such as the Global Water Partnership); regional organisations (e.g. COMESA); private organisations (such as the Evangelischer Entwicklungsdienst); and research funding organisations (e.g. IDRC and DFID). However, most of the climate finance has come from the Government [2].

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References

[1] Vincent, V. and Thomas. R. G., 1960. *Agro-ecological survey*. Government of Southern Rhodesia, Salisbury.

[2] National Climate Response strategy (NCRS)., 2014. Government of Zimbabwe, Causeway, Harare.

[3] Chikodzi, D., Zinhiva, H., Simba, F.M. and Murwendo, T., 2013. Reclassification of agroecological zones in Zimbabwe–the rationale, methods and expected benefits: The case of Masvingo Province. Journal of Sustainable Development in Africa, *15*(1), pp.104-116.

[4] 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*(2), 361-369.

[5] Third national communication (2016). Department of climate change, ministry of environment, water and climate, Harare.

[6] Unganai L. S., 2020. Downscale climate projection for Zimbabwe. 2040 estimates. Oxfam, Zimbabwe, In Press.

[7] Vermeulen, S., 2015. How to do Climate Change risk assessments in value chain projects. International Fund for Agricultural Development (IFAD). Environment and climate change. Adaptation for Smallholder Agriculture Programme (ASAP). IFAD.

[8] Intergovernmental Panel on Climate Change (IPCC)., 2014. Working Group AR5 Climate Change 2014: Impacts, Adaptation, and Vulnerability. Online: https://www.ipcc.ch/report/ar5/wg2/. Accessed 12/12/19.

[9] National Water Policy, 2013. Government of Zimbabwe. Causeway, Harare. Online: https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=3&cad=rja&uact=8&ved=2ahUKEwjUh83LmaTmAhVDMewKHUIKBlAQFjACegQIBBAC&url=http%3A%2F%2Fwww.conscientiabeam.com%2Fpdf-files%2Feco%2F74%2FIJPPAR-2015-2(3)-60-72rev.pdf&usg=AOvVaw0ziu-Le4vlO5qj_1H7xVdK. Accessed 9/12/19.

[10] National Climate policy, 2017. Government of Zimbabwe, Causeway, Harare.

[11] Zimbabwe Agriculture Investment Plan (ZAIP)., 2012. A Comprehensive Framework for the Development of Zimbabwe's Agriculture Sector 2013-2017. Causeway, Harare.

[12] Robertson, J, 2011. Statistics on the Zimbabwean economy. Www.Slidenet/Sokwanele/ Zimbabwe-economy-october-2009, accessed 28 December 2009.

[13] Dube, T., Intauno, S., Moyo, P. and Phiri, K., 2017. The gender-differentiated impacts of climate change on rural livelihoods labour requirements in southern Zimbabwe. Journal of Human Ecology, *58*(1-2), pp.48-56.

[14] Muchacha, M. and Mushunje, M., 2019. The gender dynamics of climate change on rural women's agro-based livelihoods and food security in rural Zimbabwe: Implications for green social work. Critical and Radical Social Work, *7*(1), pp.59-72.

[15] UKTP, Draft inception report., 2019. International Trade Centre (ITC), Geneva.

[16] International Trade Centre (ITC)., 2019. Environmental Mainstreaming Strategy. UK Trade Partnerships Programme. ITC, Geneva.

[17] Shonhe, T., 2019. The agrarian question in contemporary Zimbabwe. Africanus, *49*(1), pp.1-24.

[18] Scoones I., 2020. UK-Africa trade and investment: is it good for development? Online: http://ianscoones.net/blog/. Accessed 29/01/20.

[19] Moyo, S., 2011. Land concentration and accumulation after redistributive reform in post-settler Zimbabwe. Review of African Political Economy 38 (128): 257-276.

[20] Miller, C. and Jones, L., 2010. Agricultural Value Chain Finance Tools and Lessons. Food and Agriculture Organization of the United Nations. Practical Action Publishing, Dunsmore, Rugby.

[21] Moyo, M., 2014. *Effectiveness of a Contract Farming Arrangement: A Case Study of Tobacco Farms in Mazowe District, Zimbabwe*. Unpublished MPhil. Thesis, University of Stellenbosch.

[22] Scoones, I., Mavedzenge, B. and Murimbarimba, F., 2016. Sugar, people and politics in Zimbabwe's Lowveld, Journal of Southern African Studies: 1-18.

[23] Biyam, S. T., 2013. *An Overview of Farming Financial Services- Sharing Decades of Farming Finance Experience and Ideas on Farming Finance Looking into the Future*. Agribusiness Development Service Provision Business Linkage, Harare.

[24] Sachikonye, L., 2016. Old wine in new bottles? Revisiting contract farming after agrarian reform in Zimbabwe. Review of African Political Economy, 43 (1): 86-98.

[25] Malaba, S.M.T., 2014. *State of funding for agriculture and the whole value chain as well as prospects of the fourth coming agriculture summer season*. 71st commercial farmers union of Zimbabwe, Harare.

[26] Parirenyatwa, K., and Mago S., 2014. Evolution and development of contract farming. Mediterranean Journal of Social Sciences 5 (20): 237-244.

[27] Masiyandima, N., Chigumira, G. and Bara, A., 2011. *Sustainable Financing Options for Agriculture in Zimbabwe.* Zimbabwe economic policy analysis and research unit (ZEPARU), working paper series, ZWPS 02/10, Harare.

[28] Pswarayi-Jabson, G., 2018. Opportunities for Accessing International Climate Adaptation Finance for Civil Society Organizations in Zimbabwe. Africa centre for climate change knowledge foundation. Harare.