Southern Africa Economic Outlook 2022

Supporting Climate Resilience and a Just Energy Transition

GROUPE DE LA BANQUE AFRICAINE DE DÉVELOPPEMENT
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LIST OF ABBREVIATIONS AND ACRONYMS

AF	Adaptation Fund
AfDB	African Development Bank
BNA	Banco Nacional de Angola (National Bank of Angola)
CEB	Central Electricity Board
CSA	climate smart agriculture
ENSO	El Niño–Southern Oscillation
GCF	Green Climate Fund
GDP	gross domestic product
GHG	greenhouse gas
GW	gigawatt
GWh	gigawatt hours
IFAD	International Fund for Agricultural Development
ILO	International Labour Organization
IMF	International Monetary Fund
INDCs	Intended Nationally Determined Contribution
IPCC	Intergovernmental Panel on Climate Change
IRENA	International Renewable Energy Agency
MDG	Millennium Development Goal
MW	megawatt
NDC	National Determined Contribution
OECD	Organisation for Economic Co-operation and Development
PPE	personal protective equipment
PV	Photovoltaic
R&D	Research and development
RCP	representative concentration pathway
REDD+	Reducing Emissions from Deforestation and Forest Degradation
SADC	Southern African Development Community
SDGs	sustainable development goals
SDRs	Special Drawing Rights
SMEs	Small and medium-sized enterprises
UNEP	UN Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
UNICEF	United Nations International Children's Emergency Fund
UN-REDD	United Nations Collaborative Programme on Reducing Emissions from Deforestation and forest Degradation (REDD)
WFP	World Food Programme

KEY TERMINOLOGIES

Terminologies	Definitions
Agriculture, Forestry and Other Land Use	The Agriculture, Forestry and Other Land Use is a term used in 2006 Intergovernmental Panel on Climate Change (IPCC) Guidelines which describe the anthropogenic GHG emissions from two distinct sectors: agriculture and Land Use, Land Use Change and Forestry.
Climate change	Climate change as defined by the Intergovernmental Panel on Climate Change (IPCC) is "a change in the state of the climate that can be identified (e.g. using statistical tests) by changes in the mean and/or the variability of its properties, and that persists for an extended period, typically decades or longer" [Intergovernmental Panel on Climate Change (IPCC), 2007].
Climate finance	Finance to reduce emissions, and enhance sinks of greenhouse gases and which aims to reduce the vulnerability of, and maintain and increase the resilience of, human and ecological systems to negative climate change impacts.
Climate-smart agriculture (CSA)	Climate-smart agriculture is an approach that helps guide the actions needed to transform and reorient agricultural systems to effectively support development and ensure food security in a changing climate. CSA aims to tackle three main objectives : sustainably increasing agricultural productivity and incomes, adapting and building resilience to climate change, and reducing and/or removing greenhouse gas emissions, where possible (FAO, 2018).
CO2 equivalent (CO^2-eq)	The amount of carbon dioxide (CO_2) emissions that would cause the same integrated radiative forcing or temperature change, over a given time horizon, as an emitted amount of a greenhouse gas (GHG) or a mixture of GHGs.
Co-benefits	The positive effects that a policy or measure aimed at one objective might have on other objectives, thereby increasing the total benefits for society or the environment.
Decarbonization	The process by which countries, individuals or other entities aim to achieve a zero fossil carbon existence. Typically refers to a reduction of the carbon emissions associated with electricity, industry and transport.
El Niño	El Niño is a climate pattern that describes the unusual warming of surface waters in the eastern equatorial Pacific Ocean. The term El Niño was initially used to describe a warm-water current that periodically flows along the coast of Ecuador and Peru, disrupting the local fishery. (IPCC, 2018: Annex I: Glossary).
Global climate models (GCMs)	Climate models with mathematical formulations of the processes that comprise the climate system. Climate models can be used to make projections about future climate outcomes and the knowledge gained can contribute to policy decisions regarding climate change. http://ccir.ciesin.columbia.edu/nyc/pdf/q1d.pdf
Global warming	The estimated increase in global mean surface temperature (GMST) averaged over a 30-year period, or the 30-year period centered on a particular year or decade, expressed relative to pre-industrial levels unless otherwise specified. For 30-year periods that span past and future years, the current multi-decadal warming trend is assumed to continue (IPCC, 2018: Annex I: Glossary).
Greenhouse gas	Gaseous constituents of the atmosphere, both natural and anthropogenic, that absorb and emit radiation at specific wavelengths within the spectrum of thermal infrared radiation emitted by the Earth's surface, the atmosphere itself, and by clouds (IPCC Data Distribution Centre).

KEY TERMINOLOGIES

Terminologies	Definitions
Industrial processes and product use	The industrial processes and product use sector covers the greenhouse gas emissions resulting from various industrial activities that produce emissions, not directly the result of energy consumed during the process and the use of man-made greenhouse gases in products (IPCC, 2006).
Regional climate models	Climate models developed with the aim of downscaling climate fields produced by coarse resolution global climate models (GCMs), thereby providing information at fine, sub-GCM grid scales (Giorgio, 2019)
Representative concentration pathway (RCP)	A representative concentration pathway (RCP) is a greenhouse gas concentration (not emissions) trajectory adopted by the IPCC. Four pathways were used for climate modeling and research for the IPCC fifth Assessment Report (AR5) in 2014. The pathways describe different climate futures, all of which are considered possible depending on the volume of greenhouse gases (GHG) emitted in the years to come. The RCPs – originally RCP2.6, RCP4.5, RCP6, and RCP8.5 – are labelled after a possible range of radiative forcing values in the year 2100 (IPCC Data Distribution Centre).

EXECUTIVE SUMMARY

The global economic recovery is set to decelerate owing to the conflict in Ukraine. The 2021 global economic growth rate was estimated at 6.1 percent and is now projected to decline to 3.6 percent in 2022 and 2023 according to the IMF (World Economic Outlook-April 2022), lower than the January 2022 projection of 4.4 percent. The Russia-Ukraine war has exerted pressure on commodity prices and stimulated inflation – a pressure that is set to persist even after any military de-escalation, given the extent of disruption in the distribution channels for goods and services. While the outlook for commodity markets depends heavily on the duration of the war and the extent of sanctions imposed, the channels through which commodity markets have been affected are likely to persist and changes in commodity trade patterns are likely to continue. The global outlook is blurred by several additional risks including unanchored inflation expectations, financial stress, and limited policy space to provide supplementary support. Looming debt restructuring among developing countries is set to add to the economic recovery challenges. The possibility of further outbreaks of COVID-19, alongside a broader slowdown in global growth, presents downside risks for prices. Following global macroeconomic developments, commodity supply factors are expected to continue causing recurring commodity price swings, which may be amplified by the transition away from fossil fuels and the Russian-Ukraine conflict.

This global downside effect and risk are also weighing on Africa and the Southern Africa region. Following a 6.9 percent recovery in 2021, Africa's growth rate is projected to soften to 4.1 percent in 2022 and to maintain the 4.1 percent growth rate in 2023. Southern Africa continues to recover from the COVID-19 shock of 2020, with an expected growth of 2.5 and 2.4 percent in 2022 and 2023, respectively. The economic recovery is expected to persist, given the spill-over effects from major trading partners, such as China and the US. All countries in the Southern Africa region are expected to increase vaccination efforts and continue easing COVID-19 restrictions. Furthermore, a gradual recovery of the tourism sector is expected. The region's largest economies, South Africa and Angola, are expected to grow by 2 and 1.6 percent in 2022, respectively. The main drivers of this growth are the full recovery of the service sector in South Africa and rising fuel prices in Angola. In 2022, the economic recovery is anticipated to be stronger for Mauritius, Madagascar, and Botswana, relative to other countries in the region. The service sector is expected to recover faster than the industrial sector and outperform agriculture. These projections are based on the dominance of non-lethal COVID-19 variants. The conflict in Ukraine is expected to introduce a surge in the inflation rate for non-oil exporting countries, therefore Angola as the only oil-producing country in the region, is set to benefit from rising oil prices.

Fiscal and current account balances are expected to return to touching distance of their pre-COVID-19 levels as most countries are winding down pandemic fiscal and monetary interventions. This comes at a time when most Southern African countries have fiscal balances higher than the 3.0 percent SADC's macroeconomic convergence target. Some countries like Mozambique, Angola, Mauritius, and Zambia have a debt-to-GDP ratio of greater than 100%, which is above the 77% World Bank threshold. Africa received USD33 billion of the USD650 billion new SDR allocations, and countries in the Southern Africa region have significantly benefited from the Special Drawing Rights in stabilizing foreign reserves. Investment in the region is projected to slowly increase benefiting from the faster economic recovery in the advanced economies but will be constrained by tight fiscal and monetary policies. Inequality in the region is expected to remain high but the unemployment rate is likely to shrink as economic activity rebounds to pre-pandemic levels.

The region is facing multiple challenges and downside risks to its recovery including the Ukrainian war, rising commodity prices, and the lingering effects of the pandemic, including the emergence of new variants, which could highly impact economic prospects. In addition, rising inflation, high debt levels, weak current account balances, and limited fiscal space are likely to limit the capacity of the region to boost spending and financing for quicker post-COVID-19 recovery. The region also faces risks including spillovers from the tightening of global financial conditions due to elevated inflation risks in advanced economies; domestic and external geopolitical tensions and security issues; and increasing climate-related risks on economic output.

There are a few opportunities emerging for the region, namely the strengthened roll-out of mass COVID-19 vaccination; the easing of travel restrictions; the boom in the commodity market, including precious metals; a gradual recovery of the service sector led by tourism; and climate-resilient development, especially in the agricultural sector, which could dramatically improve productivity and increase employment.

Southern Africa should also take advantage of the special drawing right (SDR) allocation to: stabilize reserves and currencies; improve fiscal balance through implementing efficient revenue collection and spending patterns; combat elicit trading; widen the tax base; implement efficient tax systems; expand the complexity of regional and international trade; scale up inclusive growth; and prioritize climate-resilient development. There is also a need to improve governance; expand the value addition of commodities, including precious metals; enhance economic complexity and diversification of production and exports markets; increase the productivity of the manufacturing industry; tap into the effectiveness of national development banks networks to improve infrastructure projects; and deepen value chains with countries like China and the US, among others.

The economic outlook for Southern Africa will be affected by an additional threat that arises from global warming. The 13 countries are intertwined in a climate-water-energy-food nexus with a high reliance on climate-sensitive sectors. Consistent with the shift in global climate, Southern Africa is likely to observe a rise in mean temperature which exceeds the global mean. Models suggest that Southern Africa will experience decreased and erratic rainfall, severe droughts, episodic floods, intense tropical storms, frost, and strong winds, among other effects, which are likely to impact many sectors such as agriculture and livestock, water, tourism, and health. Climate change will eventually also impact national income, government budget, finance, growth, and development performance. The climate-related risks are even higher for the most vulnerable, often found among the rural population, youth and women employed in the agricultural sector.

The slow onset of climate change and climate-induced disasters interact with endemic economic problems such as unemployment, underinvestment, and unsustainable debt in Southern Africa. The likely consequences are therefore devastating social and economic crises including threats of food insecurity and undernourishment, poverty, growing inequality, the low participation of women in society, an increase in marginalized population, and conflicts. Women are expected to be disproportionately affected, mainly because they are engaged in activities characterized by low earnings and productivity and suffer from a lack of social security. Their limited access to and control of land, high levels of responsibility in household work, involvement in agricultural production, and lack of access to formal education add to their significant inequality.

Future economic strategy and development plans are directly linked to the impacts of climate change. Climate-related risks will negatively affect the ability of Southern African countries to accelerate their economic transformation and achieve the goals of the 2030 Agenda for Sustainable Development and the objectives of ‘Agenda 2063: The Africa We Want’. In this respect, it represents an immediate call for accelerating climate action.

Long-term measures to deliver impactful climate outcomes at the regional level include:

- Promoting a smooth and just transition, and a fair share of the costs and benefits with appropriate labour, decent work, and social protection policies;
- Reforming and harmonizing the regulatory and institutional environment in the energy sector towards expanding renewable energy;
- Building synergies between mitigation and adaptation measures to maximize its co-benefits;
- Increasing regional collaboration and cooperation across Southern African countries, especially in the electricity sector;
- Implementing climate-related innovation and smart solutions, accelerating a digital transformation alongside industrialization
- Ensuring gender participation in climate-compatible development and empowering women to be active against climate-related risks.

CHAPTER 1

RECENT ECONOMIC TRENDS AND DEVELOPMENTS

KEY MESSAGES

- **Real GDP growth in Southern Africa rebounded strongly in 2021 to 4.2 percent, up from a 6 percent contraction in 2020 and average inflation has generally remained under the 10 percent mark but remained relatively high in Zimbabwe, Angola, and Zambia**. The recovery is projected to soften to 2.5 percent and 2.4 percent in 2022 and 2023, which is largely attributed to the lingering effects of COVID-19, the Russia-Ukraine war, rising commodity prices, potential debt crises, rising inflation, and weak fiscal and external balance.

- **Due to the disruptive effects of COVID-19 on trade, Southern African countries have had positive current account balances over the period 2020/2021, which is projected to persist in 2022 and 2023**. The positive current account balances in 2020 and 2021 are attributed to the decline in imports due to lockdowns across the region as well as the collapse in oil prices in 2021 given that oil is a major import for all countries in the region except Angola.

- **The average regional debt level has been rising for most countries in 2020, reaching a peak in 2020: Angola had a debt to GDP ratio of 88.9 percent ; Mauritius's ratio was 115.1 percent ; Mozambique recorded a 196.9 percent ratio**.

The debt trend slightly declined for most countries over the period 2020-2021. However, debt levels are expected to remain higher than pre-pandemic levels as their fiscal spaces are constrained from various external risks.

- **Based on World Bank poverty and inequality data, poverty and inequality remain high across the region.** Poverty is relatively higher in Madagascar, Malawi, Mozambique, and Zambia, while inequality is higher in South Africa, Namibia, and Zambia.

- **Regional employment is recovering from the COVID-19 pandemic slump.** However, there is generally a disproportionately high unemployment rate among the youth and women. Employment is likely to take longer to fully recover from COVID-19 effects and this issue calls for the extension of government initiatives toward cushioning the unemployed through skills development, and the creation of opportunities for the vulnerable.

1.1 Introduction

This regional economic outlook reviews the recent conditions and outlook in the 13 Southern African countries amid the recovery from the COVID-19 pandemic and the Russian-Ukraine war. Part one of this report focuses on the growth and finance prospects, and the development of the 13 African Development Bank's programmatic countries in Angola, Botswana, Eswatini, Lesotho, Madagascar, Malawi, Mauritius, Mozambique, Namibia, São Tomé & Príncipe, South Africa, Zambia, and Zimbabwe. South Africa remains the region's largest economy, followed by Angola. Part one contains nine sub-sections discussing the recent macroeconomic development in Southern Africa, inflation, fiscal balances, current accounts, debt, poverty and inequality, employment trends, and the closing section outlines medium-term macroeconomic outlook.

Part two assesses climate-related risks faced by the Southern African countries on their recovery and development goals. The sub-sections are as follows : the vulnerabilities of Southern Africa region, the imperative of an energy transition, the pathways towards building climate resilience and low carbon development. Finally, sub-section 3 elaborates the opportunities and policy priorities to recover from the COVID-19 pandemic and to embark on green growth pathways.

1.2 Recent macroeconomic developments in Southern Africa

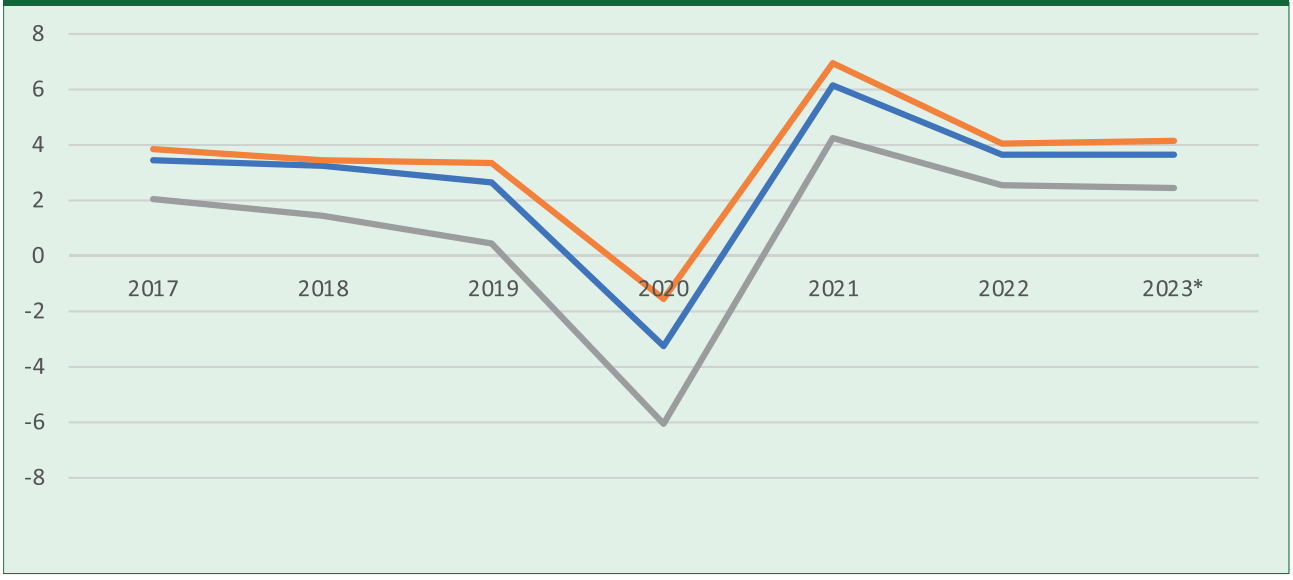
1.2.1 Growth performance and drivers

Real GDP growth in Southern Africa rebounded strongly in 2021 to 4.2 percent, up from a 6 percent contraction in 2020. The strong growth in 2021 was attributed to robust economic activity following the reopening of the region's economies, strong global growth that caused a surge in commodity prices and benefited producers of metals, minerals, and oil (Figure 1.1). In addition, Southern Africa's upward trend in 2020-2021 is also attributed to the return to 'normal' of most countries as they opened up following pandemic restrictions and unlocked economic activities. Domestic and international travel has started to grow, and industries are slowly returning towards full capacity. Confidence has been enhanced by rising vaccination levels, facilitated by relatively weaker COVID-19 variants, and improved effectiveness of health systems which are increasingly learning to deal with pandemic risks.

However, the Southern African growth rate remains below the global and continental African growth trends (Figure 1.1). The decrease in economic growth is largely attributed to the Russia-Ukraine war which has greatly affected energy prices and disrupted distribution channels. Russia is a large exporter of fuel and energy products with crude oil and natural gas being its main exports. Some of its main exports are metals, machinery and equipment, chemical products, foodstuffs, and agricultural products. These exports mainly go to China (12 percent), Germany (9 percent), the Netherlands (8.4 percent), Italy (5.8 percent), Belarus (4.7 percent), Turkey (4.4 percent) and Japan (4.1 percent). This means that the world, including Africa, will directly and indirectly be negatively affected by a Russia-Ukraine war. The region's crude fuel and gas exporting countries are likely to benefit while net crude fuel and gas importing countries will be influenced negatively by shrinking supply and rising crude oil and gas prices.

Figure 1.2 shows Africa's regional differences in economic growth. The 2020 drop in economic activities were more severe for Southern Africa (6 percent) compared to other regions. The period 2021-2022 shows a fair economic recovery in all regions compared to global growth rates. However North Africa and East Africa seem to be doing better compared to other regions in Africa. The two regions have a consistent economic growth rate of at least 4 percent over the period covered by figure 1.2, except in 2020. The 2022 and 2023 projections show Southern Africa lagging with lower performance than other regions. Figure 1.3 disaggregates the countries in the Southern Africa region to better understand the subdued economic growth in the region.

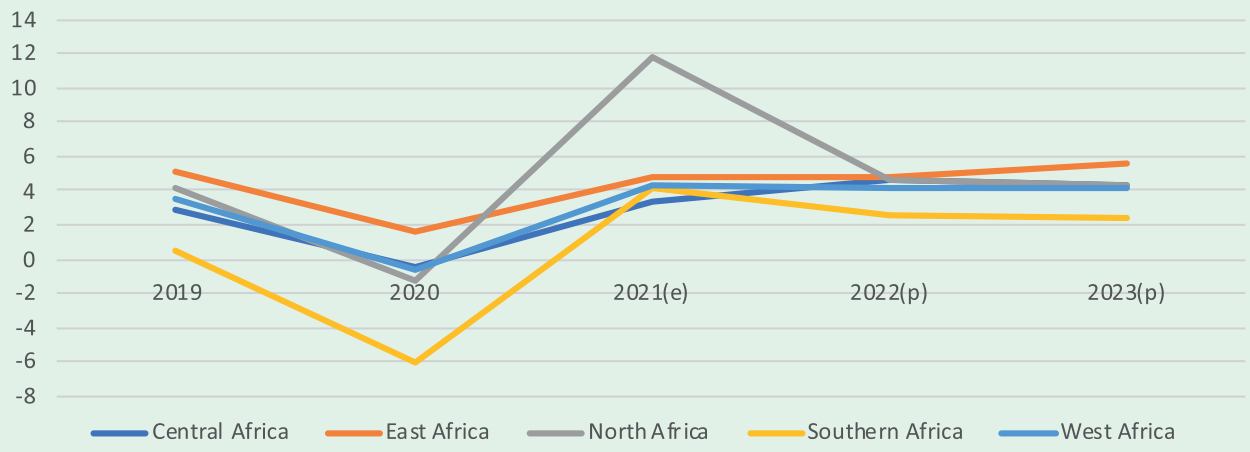
Figure 1.1 : Real GDP growth in Africa and the world, 2017-23 (percent)



Source: African Development Bank Statistics Department and IMF World Economic Outlook, incorporating the 2022 April projection revisions

The 2021 and 2022 period shows significant economic recovery for all countries in the region. In 2021 the recovery was however stronger for Botswana, Zimbabwe, and South Africa as they recorded economic growth of 12.5, 6.3 and 4.9 percent respectively (figure 1.3). Such high recovery rates are attributed to the significant growth of the industry sector in Botswana, and the service sector in Zimbabwe and South Africa.

Figure 1.2 : GDP growth rates in Africa, by region, 2019-23 (percent)



Source: AfDB Statistics Department and IMF World Economic Outlook, incorporating the 2022 April projection revisions

For 2022 the economic recovery is expected to be even stronger for Mauritius, Madagascar, and Botswana as they are projected to record economic growth rates of 6.2, 5.0 and 4.2 percent respectively. The 2023 projections show a persistent high growth in Mauritius at 5.6 and Madagascar at 5.4 percent. Zambia is projected to grow by 3.8 percent in 2023 (Figure 1.3). These strong 2022 growth rates are underpinned by complete removal of COVID-19 restrictions and production capacity returning to pre-pandemic levels, allowing full recovery.

Figure 1.3 : GDP growth, by country, 2017-23 (percent)

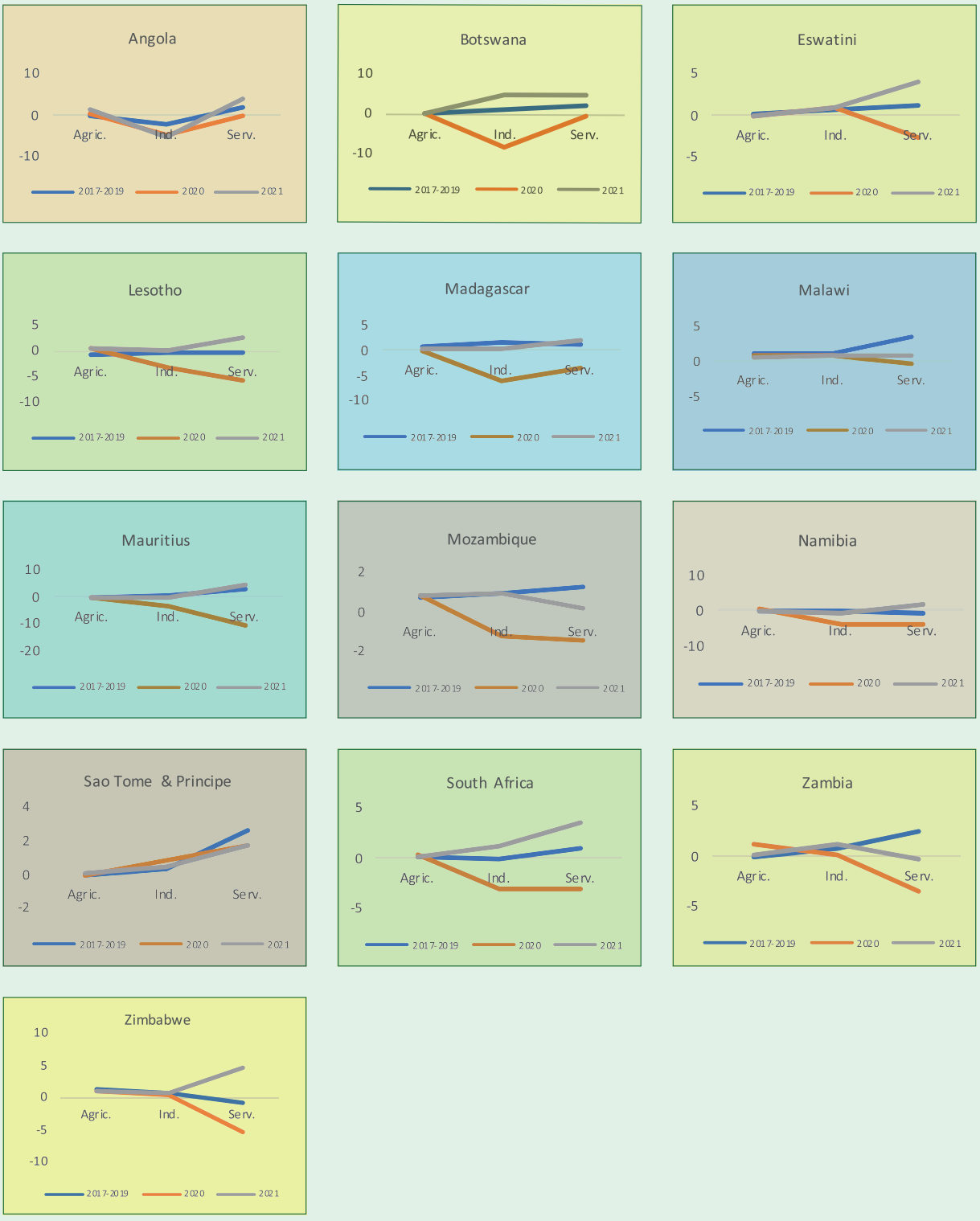
Source: AfDB Statistics Department, incorporating the 2022 April projection revisions

Figure 1.3 : GDP growth, by country, 2017-23 (percent)

Source: AfDB Statistics Department, incorporating the 2022 April projection revisions

Figure 1.4 reviews the sectorial contribution to economic growth and helps unpack the growth dynamics in the region. In terms of sectorial contribution, the service sector is the largest driver of economic growth, a homogenous pattern across the 13 countries in the Southern Africa region over the period 2017-2020[1]. In 2020 that pattern is not discernible probably due to the economic disruptions of the pandemic.

Figure 1.4 : Average sectoral contributions to GDP, by country, 2017-23 (percent)



Source: AfDB Statistics Department

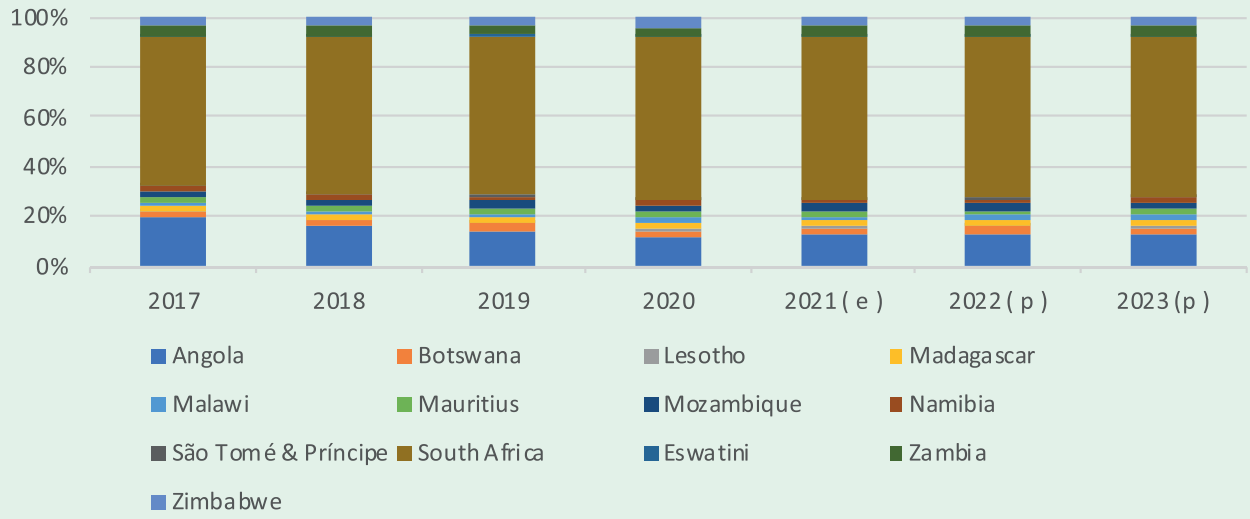
[1] Long-term data is available on demand.

The period 2020 shows the service sector being heavily affected by the pandemic, especially in Lesotho, Mauritius, Zambia, and Zimbabwe, but it has since showed signs of recovery.

The period 2021 shows a strong recovery of the service sector in all countries except Zambia. Zambia's service made a negative contribution to economic growth in 2021 with a slow recovery which might be attributed to a slower resumption of economic activity following relaxation of lockdown restriction measures. The industrial sector also shows significant recovery in 2021 as the sector returned to economic growth in all the countries except in Angola, Mauritius and Namibia. In Angola, the industrial sector was still contributing negatively to economic growth, implying that its poor performance might not be directly linked to the pandemic.

In terms of each country's contribution to the regional GDP, figure 1.5 shows a persistently high contribution by South Africa. Over the period 2019-2020, South Africa contributed an average of 64 percent to the regional GDP. Angola is the second largest contributor with an average of 13.8 percent over the same period. Since 2017, South Africa's contribution to the region increased from 58 percent to 65 percent in 2020. From 2020 to 2023 its contribution to the region is expected to remain high, at around the 64 percent mark. However, Angola's contribution to the region has significantly decreased from 20 percent in 2017 to 11 percent in 2020, with a slight increase to 13 percent in 2021. The rest of the individual countries' contributions to the region remain below 4 percent.

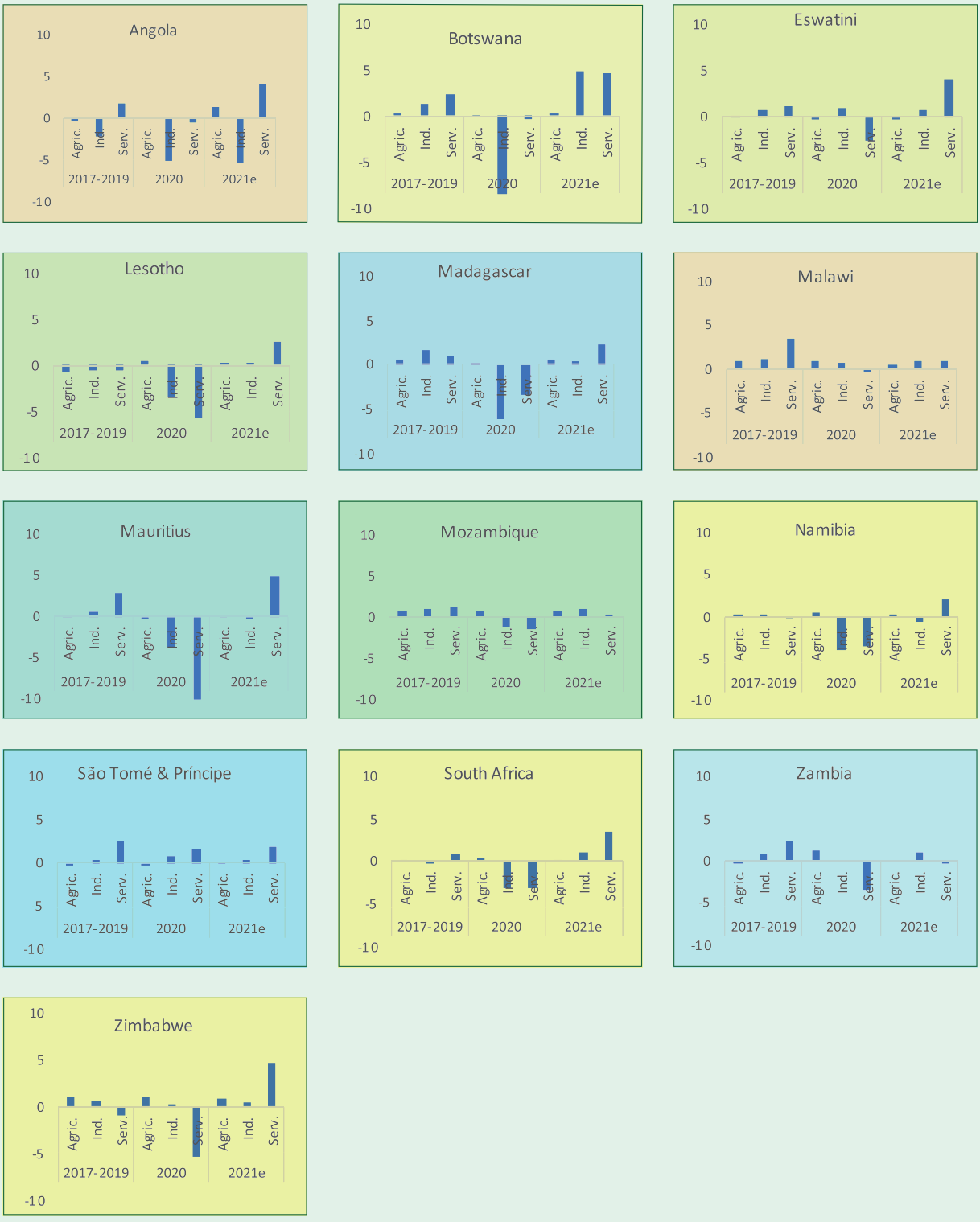
Figure 1.5 : GDP growth rates in Africa, by region, 2019-23 (percent)



Source: AfDB Statistics Department

The demand side contributions to the growth of Southern African countries are also worth considering. Figure 1.6 shows government consumption, household consumption, investment, and net exports of the region at country level. Household consumption appears to be the main driver of growth in the region, contributing 0.79, -3.96 percent and 1.54 percent to the region's growth for the periods 2017-2019, 2020 and 2021 respectively. This distribution is homogenous across the 13 countries. Except in 2020, investment is the second largest driver of growth. There was a negative investment contribution to growth of 2.52 and to offset it, government consumption had to increase its contribution to 0.53 percent in 2020 from 0.23 percent in the 2017-2019 period. This period is also characterised by increased government spending as most governments were implementing COVID-19 intervention programmes.

Figure 1.6 : Demand-side contributions to GDP growth (at market prices), 2017-21 (percent)



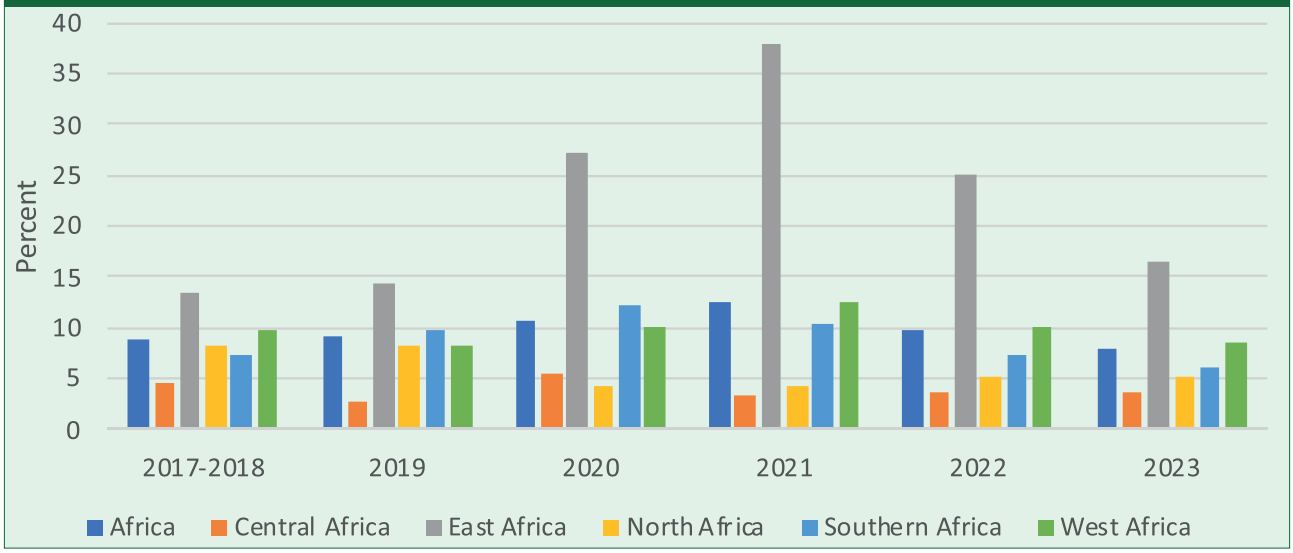
Source: Estimations using dataset from AfDB Statistics Department

Governments allocated more resources towards securing personal protective equipment (PPE) when the COVID-19 fight intensified. Some governments also supported their vulnerable populations with food handouts and social grants, as they sought to mitigate rising unemployment during lockdown. The contribution of net export is unsurprisingly negative for most countries, as can be seen in the current account (see section 1.4).

1.3 Rising inflationary pressures

The inflation rate over the period 2022-2023 is expected to be high, largely due to the effects of the Russia-Ukraine war. Russia is the third largest global producer of oil : the country produces 11,262,746 barrels of oil and exports 5,098,477 barrels of oil per day. The war is having a significant effect on both oil production and oil prices, increasing prices of all oil-based products. Such a price impact is affecting African countries as they fail to adjust quickly. Gas prices are also rising due to the war as Russia is the world's second largest producer of natural gas, behind the United States, with the world's largest gas reserves. In 2021, the country produced 762 billion cubic metres of natural gas and exported approximately 210 billion cubic metres via pipelines. The war has significantly affected production, hence rising gas prices. This tension will influence fuel and gas prices and inevitably drive inflation.

Figure 1.7 : Inflation in Africa and its regions, 2017-22 (percent)



Source: African Development Bank Statistics Department

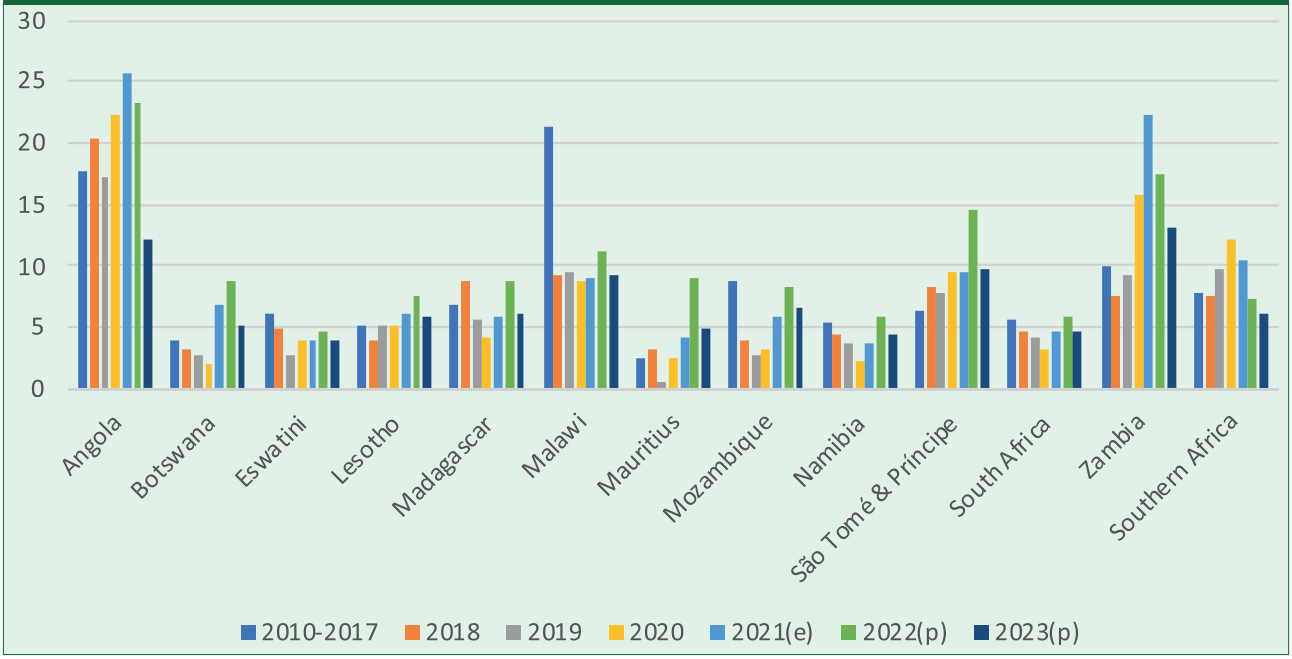
Focusing on the Southern Africa region, inflation remains relatively high in Angola and Zambia, while most countries have kept their inflation rates under 10 percent for much of 2017-2021 (Figure 1.8).

Among other factors, the high inflation rate in Angola has been spearheaded by strong demand and rising consumer prices, as in 2021 consumer prices increased 0.84 percent. The overall increase was attributed to rising prices for health services, transport, clothing and footwear, alcoholic beverages and tobacco. In contrast, prices for food and non-alcoholic beverages rose at a more moderate pace. Angola is set to gain from higher prices from oil which is its main export, but such a dynamic might also put more pressure on the inflation rate. In Zambia the high inflation rate is largely due to the government's increased spending. The fiscal deficit widened from 8.3 percent of GDP in 2019 to 11 percent of GDP in 2020, which has in turn created a high demand for government funding through increased debt, weighing on interest rates and increasing inflation rates.

Malawi has managed to dramatically reduce its inflation from 19.3 percent in 2017 to 3.5 percent in 2021. It should be noted that figure 1.8 excludes the extremely high inflation rate for Zimbabwe which would skew the true distribution[2]. Zimbabwe has the highest inflation rate in the region, recording an inflation rate of 255.3 percent, 557.3 percent and 91.8 percent in 2019-2021, respectively. Inflation is expected to remain very high, although reduced from the recent peak, with a projected inflation rate of 30.7 percent in 2022. The country is currently implementing a number of disinflation policies including fine-tuning the foreign exchange using the auction market. Such policy measures are expected to keep inflation lower.

[2] Appendix 1.1 displays the inflation rates including Zimbabwe

Figure 1.8 : Inflation in Southern Africa by country, 2017-23 (percent)



Source: African Development Bank Statistics Department, excluding Zimbabwe. Zimbabwe inflation illustrated in appendix 1-1

Box 1.1 : Russia-Ukraine war: effect on commodity prices driving inflation[3]

The war in Ukraine and related political sanctions on Russia have caused major supply disruptions and led to historic high prices for several commodities. Prices are expected to be significantly higher in 2022 than in 2021 and to remain high in the medium term. The price of Brent crude oil is projected to average $100 per barrel in 2022, representing a 42 percent increase from 2021 and reaching its highest level since 2013. Non-energy prices are also expected to rise by about 20 percent in 2022, with the largest increases in those commodities where Russia or Ukraine are key exporters. Wheat prices are forecasted to increase by more than 40 percent this year, reaching an all-time high in nominal terms. While prices generally are expected to peak in 2022, they will remain much higher than previously forecast. The outlook for commodity markets is highly dependent on the duration of the war in Ukraine and on the severity of disruptions to commodity flows, with a real risk that commodity prices could be higher for longer. These dynamics may lead to the emergence of new sources of oil supply and reduced demand for oil through a combination of efficiency improvements and the substitution of other commodities.

For policymakers, a short-term priority is to provide targeted support to poorer households facing higher food and energy prices. Over the longer term, governments can encourage energy efficiency improvements, facilitate investment in new sources of zero-carbon energy, and promote more efficient food production. Recently, however, policy responses have tended to favour trade restrictions, price controls, and subsidies, which are likely to exacerbate shortages. Some governments have responded to high fuel prices with tax cuts and subsidies. While these policies may alleviate the immediate impact of price hikes, they do not provide large benefits to vulnerable groups and may in fact exacerbate the underlying issue by increasing energy demand.

The increases in prices of some commodities have pushed up the production costs of others. For example, rising energy prices increase the cost of inputs to agriculture production, such as fuel and fertilizers. Similarly, increasing energy prices drive up the cost of extracting and refining metal ores, particularly for aluminium, iron ore, and steel. In turn, higher metal prices increase the cost of renewable energy technologies. Most commodity prices are expected to be sharply higher in 2022 than in 2021 and to remain elevated in 2023-24 compared to their levels over the past five years.

Energy and non-energy prices are forecast to rise by 50 and 20 percent in 2022, respectively, before pulling back somewhat in 2023 and settling at much higher levels than previously forecast.

The broader increase in inflation, globally, is also raising the costs of production of commodities, including through higher wages, higher transportation and storage costs, and, as interest rates increase, higher costs of borrowing.

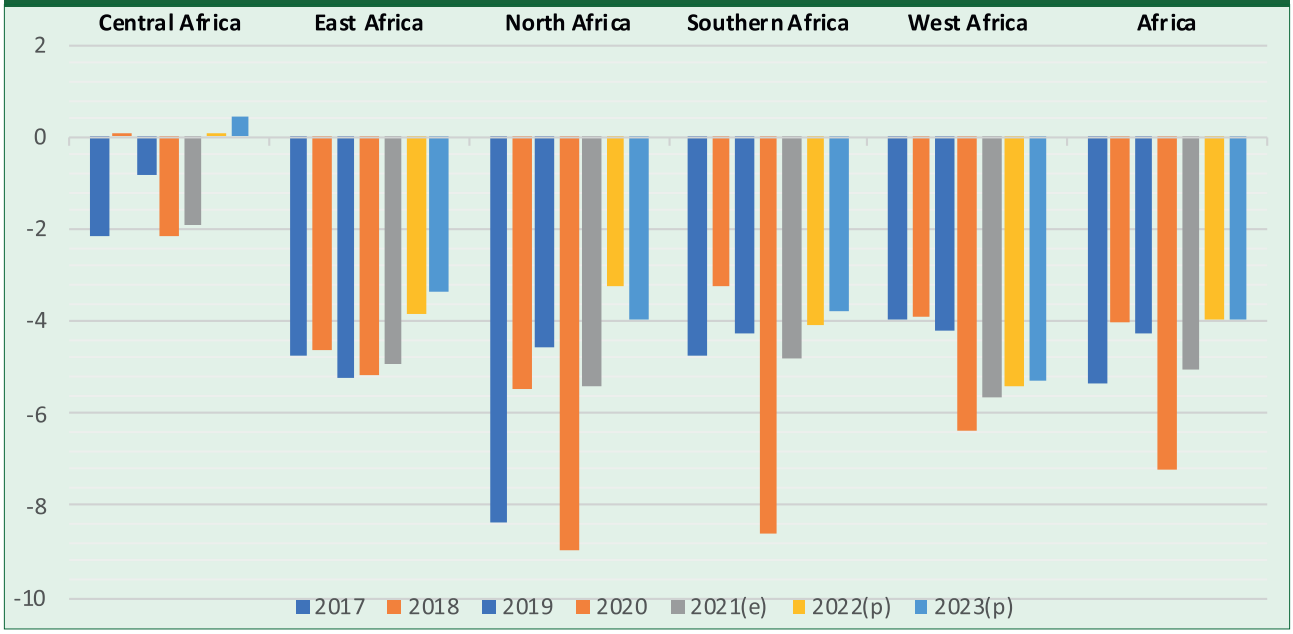
[3] World Bank, 2022: Commodity Market Outlook

1.4 Worsening fiscal balances

Limited fiscal space has been a long-standing issue for many African countries. This is illustrated by the negative fiscal balances for all regions in Africa (Figure 1.9). Huge government spending combined with small tax bases and inefficient tax collection are the main causes of the persistent negative fiscal balances. The fiscal balances worsened in 2020 possibly due to COVID-19 expenditure (Appendix 1.1). Since the beginning of the pandemic, African governments have taken fiscal stimulus measures including increased health spending, cash and in-kind transfers supporting households, expansion of social safety nets, liquidity support to firms in the forms of equity injection, asset purchases, loans and credit guarantees, and tax deferrals. The year 2021 shows lower fiscal balances but correction of the balance seems slow and is therefore expected to remain in the negative for 2023.

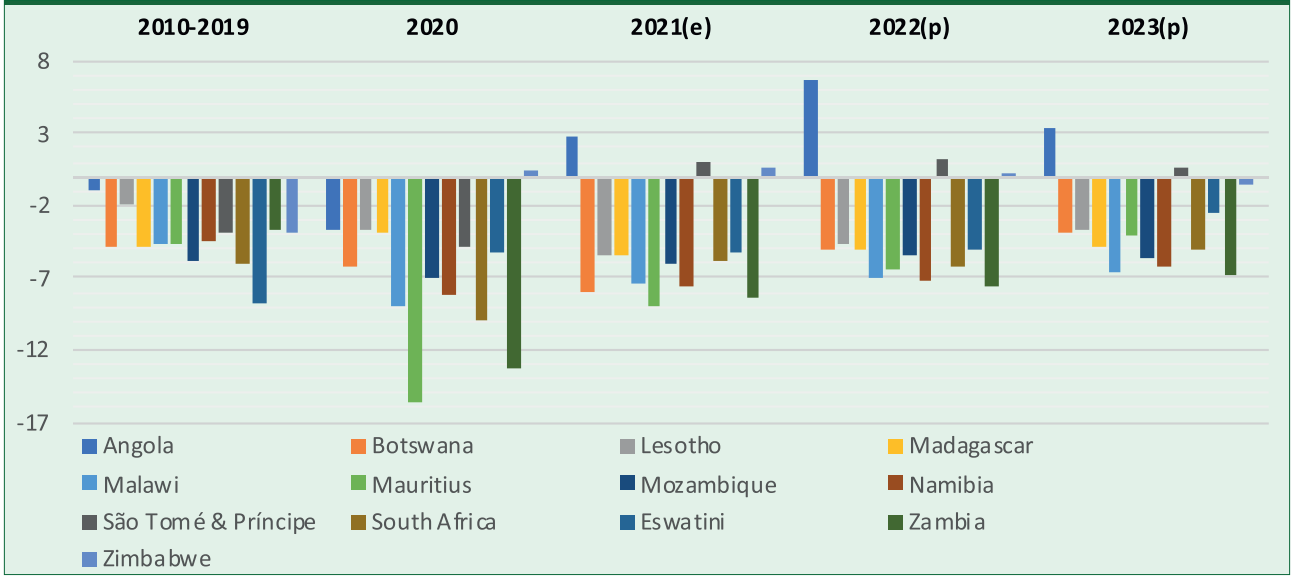
Apart from Angola, all the countries in Southern Africa have consistently negative fiscal balances (Figure 1.10). Zambia led the pack with a persistent fiscal balance above 7 percent over the period 2017 to 2022. These high fiscal balances are way higher than the 3.0 percent to GDP which is the Southern African Development Community's (SADC) macroeconomic convergence target. Angola has a positive fiscal balance of 2.4 and 1.6 as a percent of GDP in 2021 and 2022, respectively. Looking forward, this positive fiscal balance is set to plunge into the negative like other countries in the region (Appendix 1.1). Fiscal reforms will be necessary which could include budgetary discipline, reducing illicit trading, widening the tax base, implementing efficient tax systems, and cutting unnecessary government expenditure.

Figure 1.9 : Fiscal balances at regional level, 2017-23 (percentage of GDP)



Source: African Development Bank Statistics Department

Figure 1.10 : Fiscal account balance as a percentage of GDP



Source: African Development Bank Statistics Department

Box 1.2 : Angola's COVID-19 fiscal and monetary policy interventions

Angola's COVID-19 Response

Background

The first COVID-19 case was reported on March 21, 2020, while community transmission started on April 27. In June 2021, the authorities kept existing flight restrictions, limited the operating workforce of governmental and private institutions up to 50 percent, shortened the school year and approved co-payment of COVID-19 tests for international and domestic business trips. By the end of June, the average number of average daily cases reduced to 120 cases (7 day moving average) from the peak of 300 in end-May. Angola received 624,000 doses of the AstraZeneca vaccine and over 100,000 doses of the Pfizer-BioNTech vaccine delivered through the COVAX system, and a donation of 200,000 doses of the Sinopharm vaccine from the Beijing Institute of Biological Products. As of the end of June 2021, about one million people had received the first dose and over 540,000 people had received the second. However, due to the shortage of doses, authorities have stop administering the first dose vaccination until the first half of July. The vaccination plan is estimated to cost US$ 217 million and aims to cover 20 percent of the population in the first phase. The Angolan government has authorized the purchase of an additional six million doses of the Sputnik V vaccine, of which 40,000 were received. The World Bank, United Nations, European Union, African Development Bank and European Investment Bank are providing financial support and resources in several ways. In June 2021, the IMF approved the Fifth Review of the ongoing Extended Fund Facility programme and disbursed US$ 772 million in budget support, accommodating further COVID-19 vaccine procurement.

Key policy responses as of July 1, 2021

Fiscal

The National Assembly approved revenue and expenditure measures to fight the COVID-19 outbreak and minimize its negative economic impact. About US$40 million of additional health care spending was announced and a further US$80 million was invested in recruiting 250 Cuban doctors to support healthcare programmes in Angola. Tax exemptions on humanitarian aid and donations and some delays on filing taxes for selected imports were granted. On July 28, 2020, the National Assembly adopted a conservative supplementary budget, aiming at securing space for additional health expenditure, while balancing the need to keep debt on a sustainable path. The 2021 budget consolidated the non-oil revenue gains and expenditure restraint of the 2020 budget, while protecting priority health and social spending. On May 17, 2021, an additional US$ 33 million was approved for the purchase of four million vaccine doses through the African Union.

Monetary and macro-financial

In March 2020, the Central Bank of Angola (BNA) reduced the rate on its 7-day permanent liquidity absorption facility and expanded its credit stimulus programme to selected sectors. Financial institutions were requested to grant their clients a moratorium of 60 days for servicing debt. On April 3, the BNA increased the minimum bank credit allocation to producers of priority products and instructed banks to provide credit in local currency to assist importers of essential goods. On May 7 2020, the BNA reinstated its Permanent Overnight Liquidity Provision facility to provide liquidity support to banks (Kz 100 billion), and extended access to large non-financial corporations on a discount line created to purchase government securities. However, with inflation steadily rising and the worst of the shock seemingly past, the BNA shifted to a gradual tightening in the second half of 2020. Actions included the enhanced use of open market operations to drain excess liquidity from the system and an increase in the reserve requirement on banks' foreign exchange deposits (to be settled in domestic currency) in September. In March 2021, the BNA implemented additional measures to control inflation, including increasing the 7-day permanent liquidity absorption facility (reversing the cut in the same rate made in March 2020) and, in May 2021, again increased the reserve requirement on banks' foreign exchange deposits. In June 2021, BNA requested the financial institutions to grant companies of the sectors most impacted by the pandemic (transport, tourism and sports), a moratorium of up to 6 months for servicing debt.

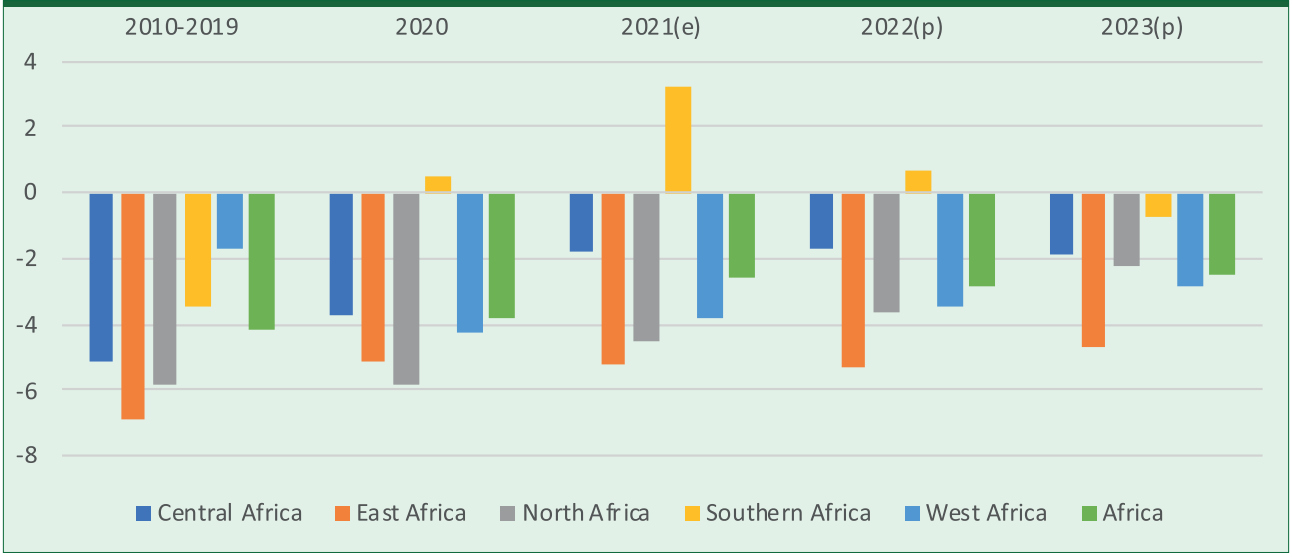
Exchange rate and balance of payments

On April 1 2020, the Central Bank introduced an electronic platform for foreign exchange transactions. By May 2021 transactions between the largest players, including those in the oil and diamond sectors, Treasury and BNA, were carried out on the platform. Exchange rate futures were also traded in the platform.

1.5 Subdued current accounts balances

The inflation rate over the period 2022-2023 is expected to be high, largely due to the effects of the Russia-Ukraine war. Russia is the third largest global producer of oil : the country produces 11,262,746 barrels of oil and exports 5,098,477 barrels of oil per day. The war is having a significant effect on both oil production and oil prices, increasing prices of all oil-based products. Such a price impact is affecting African countries as they fail to adjust quickly. Gas prices are also rising due to the war as Russia is the world's second largest producer of natural gas, behind the United States, with the world's largest gas reserves. In 2021, the country produced 762 billion cubic metres of natural gas and exported approximately 210 billion cubic metres via pipelines. The war has significantly affected production, hence rising gas prices. This tension will influence fuel and gas price and inevitably drive inflation.

Figure 1.11 : Current account balances in the Southern Africa region, 2017-23 (percentage of GDP)



Source: African Development Bank Statistics Department

Figure 1.12 disaggregates the Southern Africa current account balances by country. Significant heterogeneity is observed in the distribution of current account balances with some countries recording negative and others positive current account balances. The heterogeneity persists before and during the COVID-19 period.

Malawi, Mauritius, Mozambique, Namibia and South Africa have persistent negative current account balances. These countries are projected to maintain this trend in 2022 and 2023. Mozambique has the highest negative balance of -29.7; -9.23; -13.5 percentage of GDP for the period 2010-2019, 2020 and 2021, respectively. Angola and Botswana are the only countries in the region with a persistent positive current account balance. Botswana has been expanding its international complexity through entering new markets and diversifying its export composition, but Angola's success might be attributed to the large oil export sales even during 2021 when oil prices dropped. For all the countries the main drivers of the current account deficit continue to be the trade deficit and net factor payments abroad.

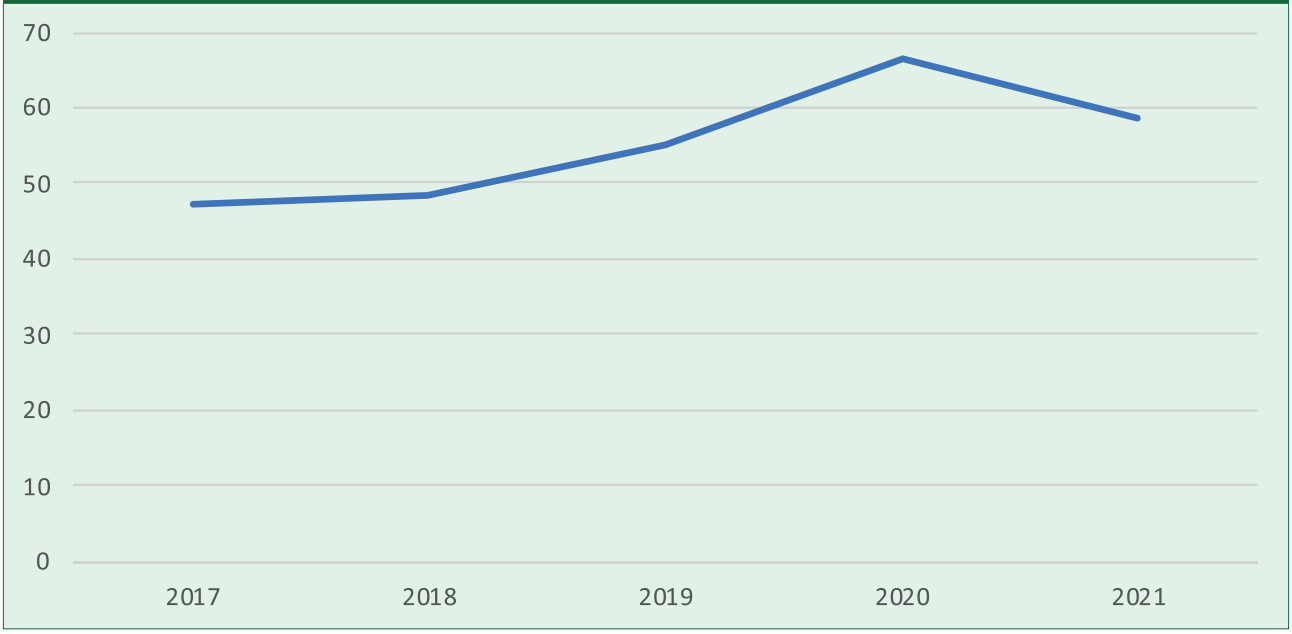
Figure 1.12 : Current account balances in Africa and its regions, 2017-23 (percentage of GDP)

Source: African Development Bank Statistics Department

1.6 Persistent debt level risk in the region

The average regional debt level has been rising to reach a peak in 2020 (Figure 1.13). The trend shown is attributed to weak public finance management systems, security expenditure, weaknesses in revenue mobilization, and increased government spending due to the pandemic. There is a modest decline in debt level between 2020-2021 despite which debt levels are expected to remain higher than pre-pandemic levels, as countries need additional resources to cushion their economies from various external risks.

Figure 1.13 : External debts as a share of GDP: Southern Africa (percent)



Source: African Development Bank Statistics Department

At a country level, Figure 1.14 illustrates the heterogeneous picture among countries regarding external debt accumulation levels. Mozambique and São Tomé & Príncipe are in debt distress while Zambia has a high debt level, and Madagascar, Malawi, and Lesotho have moderate debt levels. The high debt levels persist despite various debt relief initiatives. In 2020 the World Bank and the International Monetary Fund set up the Debt Service Suspension Initiative (DSSI). The initiative was established to help countries concentrate their limited resources on fighting the COVID-19 pandemic and safeguarding the lives and livelihoods of millions of the most vulnerable people. Forty-eight of 73 eligible countries participated in the initiative and a total of $12.9 billion in debt-service payments owed by participating countries to their creditors was suspended. In Africa the DSSI initiative has potential savings representing 24.5 percent of total debt service payments of African countries for 2020 and 40.1 percent for 2021. The savings might be modest but if used effectively they can have significant impact on debt reduction. Another debt reduction initiative was the move by the World Bank, the International Monetary Fund and the G20 to expand the number of creditors to include the Paris Club and China creditors in the DSSI under the Common Framework initiative. Including China would greatly help African countries given that China is one of the emerging large official bilateral creditors for many African countries.

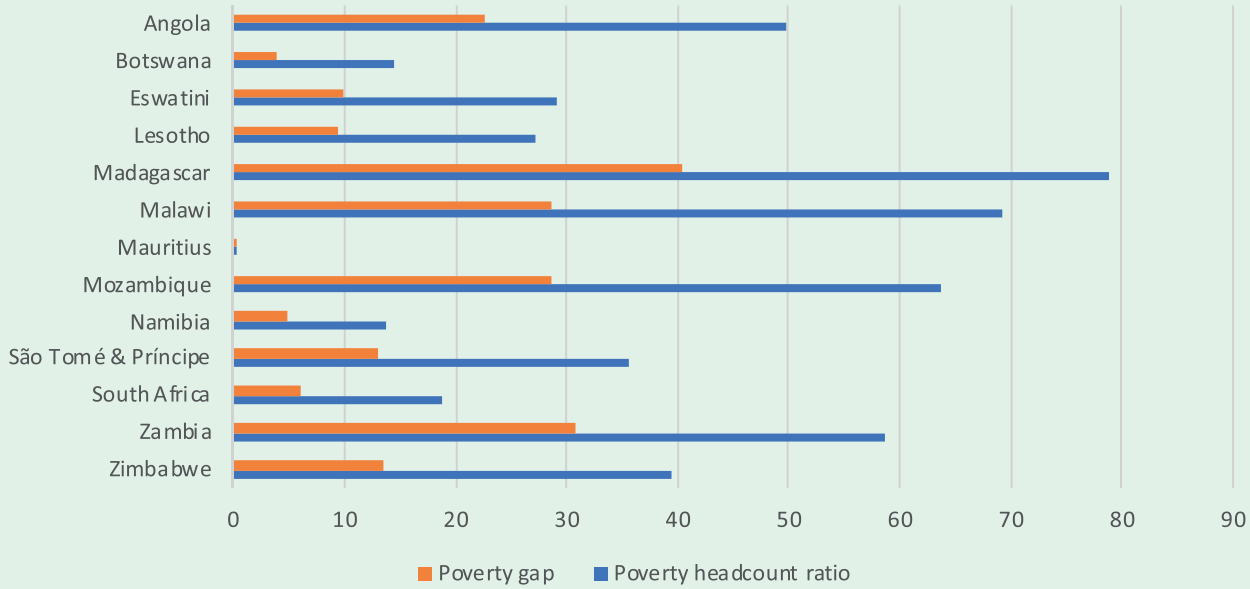
Figure 1.14 : Debts as a share of GDP, at country level (percent)

Source: African Development Bank Statistics Department

1.7 Persistent poverty and inequality pressure

Poverty and inequality remain the top priority for region to achieve the global sustainable development goals (SDGs). SDG 1 is set to end poverty in all its forms everywhere, while SDG 10 describes the goal for reducing inequality within and among countries. The poverty headcount ratio in figure 1.15 shows significantly high poverty endemic across the region.

Figure 1.15 : Poverty in Southern Africa by country using the international poverty line, various years (%)



Source: https://data.worldbank.org/indicator/SI.POV.DDAY?end=2019&start=2010.
** The international poverty line is $1.90 a day based on purchasing power parity (PPP) in 2011. The most recent available data are presented because annual data are not available for each country.*

Using the $1.90 per day threshold as a poverty indicator, Madagascar has the highest poverty levels followed by Malawi, Mozambique, and Zambia. Mauritius has the lowest share of its population living below the poverty line.

Figure 1.16 explores the levels of inequality in the region. The figure shows high levels of inequality in the region. The Gini index is a measure of the distribution of income across a population. A higher Gini index indicates greater inequality, with high-income individuals receiving much larger percentages of the total income of the population.

Figure 1.16 : Inequality in Southern Africa by country, (Gini Index) 2010-19 (percent)

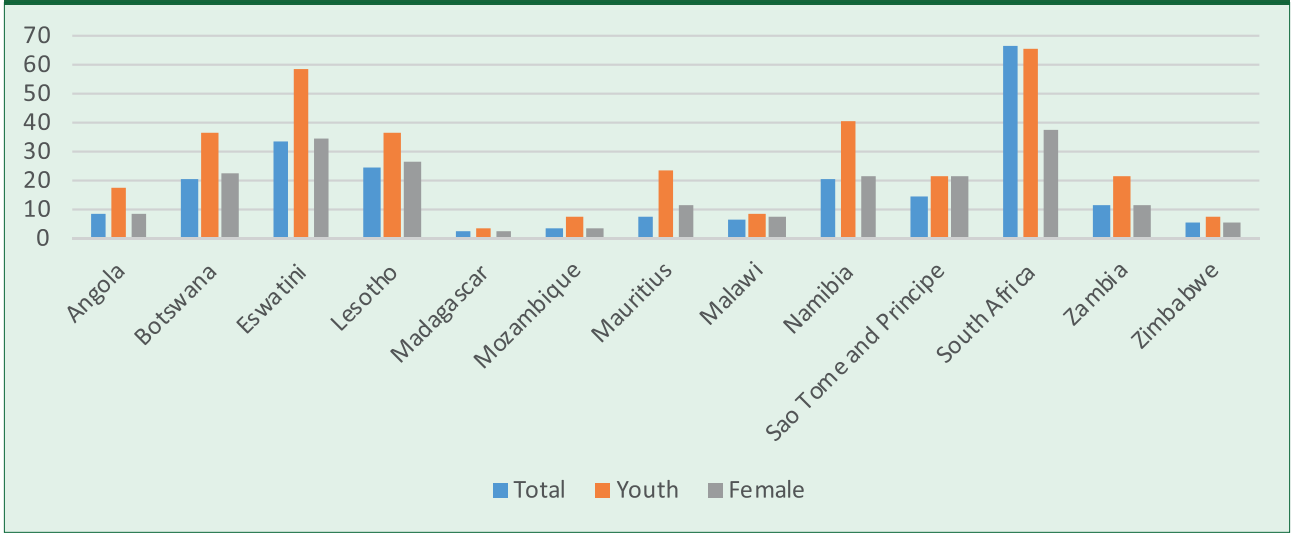
Source: https://data.worldbank.org/indicator/SI.POV.GINI?end=2019&start=2010

1.8 Recovering employment trends

Figure 1.17 shows the regional unemployment trends. There is generally disproportionately high unemployment among the youth in particular. South Africa has the highest youth unemployment at 66.5 percent followed by Eswatini with 58.2 percent. The high youth unemployment in South Africa probably also explains its stark inequality levels. It is surprising that Madagascar has the lowest unemployment level, yet is among the countries with high poverty using the head count ratio. This might be due to the relative nature of poverty measurement and the limited inclusive growth dynamics in the country. The unemployment rate among females is also highest in South Africa with an unemployment rate of 37.3, followed by Eswatini and Lesotho with unemployment rates of 33.9 percent and 26.1 percent respectively.

Employment levels are likely to take longer to fully recover from the effects of the COVID-19 pandemic. Some firms have experienced cost-cutting associated with the transition to online offices and some types of jobs might not return should firms continue with remote working. In addition, the pandemic had a devastating global socio-economic impact that will have severe long-term development implications. Policy responses have varied but many governments around the world responded by introducing economic stimulus programmes, where a major component is some form of fiscal spending to stimulate employment. Broadly, programmes in this category have aimed to limit negative labour market consequences while also aiding a post-pandemic employment recovery. Importantly, such policy responses have not been confined to advanced economies. Indeed, COVID-19 has precipitated an extensive and rapid adoption of targeted employment programmes in emerging economies that is unprecedented. The specific programmes that are being funded are wide-ranging in both nature and scope, but what is clear at the outset is that the vast majority of countries have been allocating significant resources towards employment protection and business support.

Figure 1.17 : Unemployment in Southern Africa by country, 2017-19 average (percent)



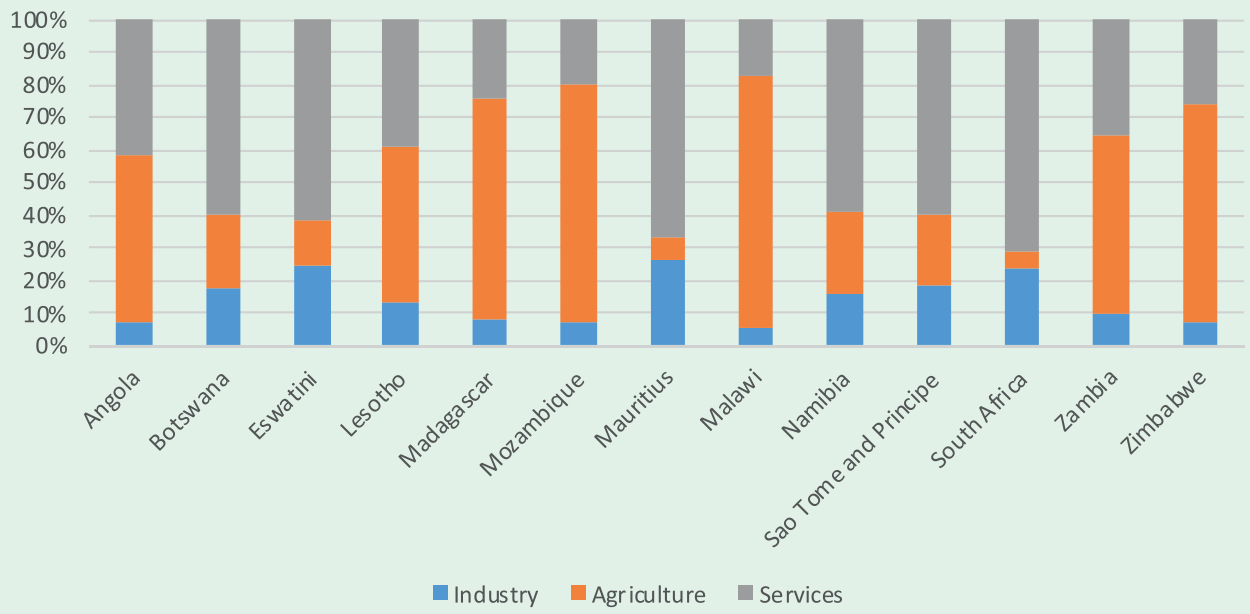
Source: https://data.worldbank.org/indicator/SL.UEM.1524.ZS?end=2019&start=1977

A disaggregation of employment contributions by sector shows the agriculture and service sectors are the largest employers and the industrial sector employs the fewest people. Such distribution points to low levels of industrialisation in the region. Although the services sector has higher productivity than agriculture, it differs substantially in terms of productivity. There are generally two ways to classify the service sector: traditional service and modern service[4]. The traditional services sector consists of wholesale and retail, government and community, social and the personal services sectors. The modern services sector comprises transport, financial, business and real estate services. The former is characterised by low productivity, explained partly by a large degree of informality, especially in the wholesale and retail sector. In contrast, the modern services sector usually enjoys stronger productivity, characterised by a high level of capital intensity and is more often located within the formal sector of the economy[5]. Rising employment in the modern service sector rather than the traditional service sector is most likely to be beneficial for the region more broadly.

[4] Ghani, Ejaz. (2010). Is Service-Led Growth a Miracle for South Asia? In The Service Revolution in South Asia, ed., Ejaz Ghani. New York: Oxford University Press., ed., Ejaz Ghani. New York: Oxford University Press.

[5] Circera, X., Lage, F., & Sabetti, L. (2016). ICT use, innovation, and productivity: Evidence from Sub-Saharan Africa. World Bank Policy Research Working Paper No. 7868.

Figure 1.18 : Sectoral contributions to employment in Southern Africa, 2010-20 average (percent)



Source: World Bank, 2021. https://data.worldbank.org/indicator

1.9 Medium-term macroeconomic outlook

The economic recovery is expected to persist supported by recovery of the region's major trading partners: China and the US. A gradual recovery in tourism is expected following growing vaccination levels and easing of travel restrictions. The region is estimated to grow by 2.3 and 2.4 percent in 2022 and 2023 respectively. The services sector is anticipated to recover fully as COVID-19 restrictions are removed. Such projections are subject to wider pandemic effects and the risk of more dangerous future variants. Additional threats to the expected improving growth rate are climate change effects and disaster and other risks, such as tropical cyclone, flooding, drought, rising poverty, food prices, food insecurity, and the effect of Russian and Ukraine conflict on the prices of commodities such as wheat, fertilisers and oil.

The region's major economic contributor, South Africa, is expected to record 2 percent and 1.5 percent growth in 2022 and 2023 respectively, as 27 percent of the population were fully vaccinated by the end of 2021. A complete relaxing of restrictions was executed in South Africa once the public health authorities managed to suppress the effects of the Omicron variant. Such developments will boost the recovery of the tourism industry. Private consumption is expected to recover but high inequality, increasing debt level and unemployment will continue to impede further meaningful growth.

Angola, the region's second largest economy is also set to recover from the COVID-19 pandemic and recent oil price shock. Oil price income is set to improve for the country as an effect of the Ukraine conflict. Such development will stabilise the Kwanza and support the fast implementation of structural reforms. Increasing agricultural production in Lesotho, Zambia and Zimbabwe will be encouraged by good rainfall and strong food prices. However, drought will remain a serious threat to meaningful agriculture growth. The negative fiscal balance will persist but be lower relative to the 2020 levels. Exports are set to improve but are also likely to be accompanied by a high import bill, keeping the current account balances negative overall.

The Southern Africa average inflation rate is expected to rise largely due to the Ukraine war, from an estimated 10 percent in 2021 to 11 percent in 2022, although it is projected to soften to 7.3 percent in 2023. The war has significant effects on the supply and pricing of oil and natural gas. The state of inflation in the region is also expected to be worsened by the rising commodity prices following the surge in grain prices. Employment rates are likely to improve as most countries fully open their economies following the drop in COVID-19 cases and corresponding increase in vaccination rates. As the industrial sectors increase their productive capacity exports should improve and trade balances will filter through to the current accounts. Southern African average fiscal balances are likely to slowly improve from a -4.8 percent in 2021 to -4.0 percent in 2022 and are projected to be -3.8 percent in 2023, as most governments are still winding up some COVID-19 intervention measures. Debt crisis remains a risk following the large accumulation of debt created by funding COVID-19 intervention programmes. The 2021 regional average debt to GDP ratio is 59 and is projected to increase to 60 in 2022 and 2023. The forces driving high debt risk include weak public finance management systems, increased security spend, high inflation, weaknesses in revenue mobilization, and increased government spending due to the pandemic. In light of the above opportunities and risks, countries in the region are advised to coordinate monetary and fiscal resources towards to contain inflation while safeguarding economic recovery and protecting the most vulnerable.

CHAPTER 2

CLIMATE RESILIENCE, RENEWABLE ENERGY AND JUST TRANSITION

The economic outlook for Southern Africa is likely to be affected by an additional threat arising from climate change. This threat could severely exacerbate the existing economic vulnerabilities. Global warming is likely to reach 1.5°C between 2030 and 2052 if GHG emissions increase at the current rate, triggering higher climate-related risks to natural and human systems[6]. Climate models and scenarios indicate that the Southern African region will be among the most seriously affected regions in the world, with inadequate physical infrastructure (including transport, communication, power generation, water storage and distribution, sanitation and sewage disposal). Observations show that the predicted droughts, floods, and El Nino[7] climate events have all occurred in Southern African countries[8], together with the spread of pests and diseases, decreasing water quality due to erosion, rising frequency of flash floods and water pollution[9]. Erratic rainfall, dry spells, flooding, and extreme weather events have an acutely negative impact on economic activities, especially in the important agricultural sector.

Such slow onset climate impacts together with high impact events interact with enduring economic problems in Southern African countries such as inflation, worsening fiscal balances, unsustainable debt, negative current account balances, unemployment and underinvestment, as elaborated in section 1. The consequences could result in devastating social crises including higher poverty, growing inequality, low women's equality, increasingly marginalised populations and conflicts. Limited resilience and adaptive capacity further contribute to their multifaceted challenges[10]. The impacts may ultimately hinder the recovery pathways from the COVID-19 pandemic and impede the achievement of many critical development objectives including economic transformation and the ability of the Southern African countries to attain the goals of the 2030 Agenda for Sustainable Development and of Agenda 2063: The Africa We Want. In this respect, these risks represent an immediate call for enduring climate action.

Climate change also presents an opportunity to facilitate and accelerate structural change in many Southern African countries. Climate-related risks can be reduced by both incremental and transformational adaptation, and by the upscaling and acceleration of multilevel and cross-sectoral climate mitigation. At the same time, economic transformation is required to help Southern African states to increase resilience and adapt swiftly to the impacts of climate change. The development of clean energy across Southern Africa is essential to increase energy access to their population, which is a prerequisite for both structural change and to avoid lock-in of public investment in fossil fuel energy. The options and choices being faced at present matter.

The extreme vulnerability of Southern African countries to the shocks from commodity prices, the Ukraine conflict, and climate-related risks together with endemic economic problems, and the effects of the COVID-19 pandemic remain at the epicentre of its economic outlook. The economic future depends on how these shocks are confronted through developing climate resilience and accelerating a just energy transition. This is the focus of section 2.

[6] IPCC (2018) Ibid.

[7] El Niño is a climate pattern that describes the unusual warming of surface waters in the eastern equatorial Pacific Ocean. Trade winds and atmosphere are also impacted by El Niño. https://www.nationalgeographic.org/encyclopedia/el-nino/#:~:text=Encyclopedic%20Entry%20Vocabulary-,El%20Ni%C3%B1o%20is%20a%20climate%20pattern%20that%20describes%20the%20unusual,%2DSouthern%20Oscillation%20(ENSO).

[8] This results from the increased presence of sediments and nutrients in water bodies.

[9] Nhamo, L., Matchaya, G., Mabhaudhi, T., Nhlengethwa, S., Nhemachena, S., and Mpandeli, S. (2019). Cereal Production Trends under Climate Change: Impacts and Adaptation Strategies in Southern Africa. Agriculture, vol.9, no.2, pp.1-16.

2.1. Southern African economies' vulnerabilities to climate change and the imperative of an energy transition

2.1.1. Climate change in Southern Africa: observations and predictions

Rising temperatures and fluctuating patterns of precipitation exert a large influence on the prosperity of the Southern African region. There are differences in the climate system and geography across the sub-regions which lead to diverse climate zones and weather conditions. Table 2.1 highlights the principal geographical characteristics of the Southern African countries: six countries are landlocked, four border the ocean and three are island states. The seven states bordering the ocean are likely to face the consequences of sea-level rise, together with the effects of rising temperature in the ocean, affecting the marine resources as well as a large number of human settlements in the coastal regions. Most countries in the region are located on the mainland and consist of a plateau 1 to 1.5km high and a narrow coastal belt that is particularly mountainous in South Africa, leading to sharp topographic gradients. These differences in topography lead to marked gradients in rainfall and vegetation across Southern Africa[11] with more arid conditions in the West and increasingly humid conditions toward the East[12](Figure 2.1), influencing the economic activities of the region.

Table 2.1 : Key characteristics of Southern African countries

Countries	Size of land area and inland waters[a]	Population (000) (2020)[b]	Geographical characteristics
Angola	1,246,700[c]	32,866.27	Coastline - Atlantic Ocean
Bostwana	581,730	2,351.63	Landlocked
Eswatini	17,364	1,160.16	Landlocked
Lesotho	30,355	2,142.25	Landlocked
Madagascar	587,041	27,691.02	Island – Indian Ocean
Malawi	118,484	19,129.96	Landlocked
Mauritius	2,040	1,265.74	Island – Indian Ocean
Mozambique	801,590	31,255.44	Coastline – Indian Ocean
Namibia	824,292	2,540.92	Coastline – Indian Ocean
São Tomé & Príncipe	964	219.16	Island
South Africa	1,221,037	59,308.69	Coastline - South Atlantic and Indian Oceans
Zambia	752,618	18,383.96	Landlocked
Zimbabwe	390,757	14,862.93	Landlocked

a- United Nations Statistics Division (UNSD) https://unstats.un.org/unsd/environment/totalarea.htm (Retrieved on 12/02/2020). The sizes are reported figures, not from country-level official sources. Numbers are therefore indicative.
b- World Bank Indicators. https://data.worldbank.org/indicator/SP.POP.TOTL (retrieved on 12/02/2022)
c- Including the enclave of Cabinda.

[10] World Food Programme (2021).
[11] Reason, C. Climate of Southern Africa. Oxford Research Encyclopaedia of Climate Science. Retrieved 3 Mar. 2022, from https://oxfordre.com/climatescience/view/10.1093/acrefore/9780190228620.001.0001/acrefore-9780190228620-e-513.
[12] Kuivanen, K., Alvarez, S., Langeveld, C., 2015. Climate Change in Southern Africa: Farmer's Perceptions and Responses. Farming Systems Ecology, Wageningen University, Wageningen, Netherlands.

Figure 2.1 : Geography of Southern Africa

Source: Shapefiles from https://data.humdata.org/ (QGIS 13.3.1)

Consistent with major shifts in global climate, Southern Africa has witnessed rising trends in annual mean, maximum, and minimum temperature over large areas of the sub-region during the last half of the twentieth century, with the most significant warming occurring during the last two decades[13]. Minimum temperatures have increased more rapidly relative to maximum temperatures over inland Southern Africa. Warning trends include an increase in extreme warm indices[14], that is, hot days, hot nights, hottest days and a decrease in extreme cold indices, that is, cold days and cold nights in recent decades[15]. With the minimum temperatures rising faster than the maximum for the whole region, there is also a notable decrease in cold extremes and an increase in warm extremes[16].

A reduction in late austral summer precipitation has been reported over its western parts, extending from Namibia through Angola during the second half of the twentieth century. Modest downward trends in rainfall are found in Botswana, Zimbabwe, and western South Africa. Some countries have experienced fewer late summer rains and a modest decrease in rainfall[17]. Annual rainfall has decreased over the African continent from the equator as well as in Madagascar, resulting in a shorter and weaker rain season in Southern Africa. Rainfall in Angola, Zambia, and Namibia tends to decrease from December to March. In fact, rainfall trends are characterised by more severe droughts in the southwest of Southern Africa and enhanced rainfall further north in Zambia, Malawi, and northern Mozambique[18].

[13] IPCC (2014) Climate Change 2014 Impacts, Adaptation, and Vulnerability Part B: Regional Aspects. Working Group II Contribution to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change pp.1206.

[14] Expert Team on Climate Change Detection and Indices (ETCCDI) (CCl/WCRP-Clivar/JCOMM) had the mandate to address the need for the objective measurement and characterization of climate variability and change.

[15] IPCC (2014), (ibid) pp. 1211.

[16] IPCC, 2021: Summary for Policymakers. In: Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [Masson-Delmotte, V., P. Zhai, A. Pirani, S.L. Connors, C. Péan, S. Berger, N. Caud, Y. Chen, L. Goldfarb, M.I. Gomis, M. Huang, K. Leitzell, E. Lonnoy, J.B.R. Matthews, T.K. Maycock, T. Waterfield, O. Yelekçi, R. Yu, and B. Zhou (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, pp. 3–32, doi:10.1017/9781009157896.001.

[17] Kuivanen et al., 2015 (ibid).

[18] Kusangaya, S., Warburton, M.L., van Garderen, E. A., and Jewitt, G. P. W. 2014. Impacts of climate change on water resources in southern Africa: A review. Physics and Chemistry of the Earth vol.67-69, pp47-54.

[19] The United Nations Intergovernmental Panel on Climate Change (IPCC) has defined four different scenarios, called Representative Concentration Pathways (RCP), which differ in their ability to dissipate heat, ranging from the optimistic (2.6) to the pessimistic (8.5) scenario, through the intermediate scenarios 4.5 and 6.0. The difference between these two intermediate scenarios is when radiation stabilization occurs, respectively, before 2060 or in 2100. The RCP2.6 for example represents a very strong mitigation scenario, whereas the RCP8.5 assumes a business-as-usual scenario.

[20] IPCC (2014), pp.1206.

[21] IPCC (2021).

Projections show that temperature changes will not be uniform over the region. The central, southern land mass extending over Botswana, parts of north-western South Africa, Namibia and Zimbabwe are likely to experience the greatest increases in temperature. Climate model projections show that mean land surface warming in Southern Africa is likely to exceed the global mean land surface temperature increase in all seasons. Changes in mean annual temperature for Representative Concentration Pathway (RCP)8.5[19] (the worst-case business-as-usual scenario) follows a pattern of larger changes in magnitude over northern and Southern Africa, with (relatively) smaller changes in magnitude over central Africa[20]. Among the predictions are an increase in frequency of warm days and nights, decrease in frequency of cold days and nights (medium confidence), and likely surface drying by the end of the century under (RCP)8.5. The annual number of heatwaves is projected to increase[21].

Decreases in mean annual precipitation are projected over areas of Southern Africa beginning in the mid-21st century for RCP8.5 and expanding substantially later in the century for RCP8.5. Drier winters are also projected over a large area in Southern Africa by the end of the century. Rainfall decreases are also projected during austral spring months, implying a delay in the onset of seasonal rains over a large part of the summer rainfall region. Mean annual rainfall in the summer rainfall region is projected to decrease by 10–20%, accompanied by an increase in the number of consecutive dry days during the rainy season under RCP8.5.

Changes associated with rising temperature are likely to bring about shorter and more intense rainfall bursts occurring with less frequency and with extended dry periods between events. Drought frequency will increase and duration will double from two to four months[22]. This projection arises mainly because the intensity of heavy precipitation has increased in parts of Southern Africa, as well as the length of dry spells which has also changed[23], with a rate of increase of around 6–7% per degree Celsius. Tropical cyclones are projected to become less frequent but with more intense rainfall and higher wind speeds as global warming increases.

2.1.2. Impacts of climate change

Macroeconomic and development risks

Climate change has many negative impacts on macroeconomic outputs. These effects include decreasing labour productivity induced by heat extremes, falling crop yields and exports, damaging property and infrastructure, mass migration and security threats. Climate change eventually impacts on government budget, finance, and economic growth. Southern Africa will most likely observe a fall of 10 percent by 2050[24]. Table 2.2 shows the expected decline in GDP per year for four climate scenarios for the Southern Africa region as well as other regions of Africa. The Southern African region is relatively close to the estimates of Central Africa; a higher negative impact is observed compared to Northern Africa, but lower than West and East Africa. The estimation was however made before the COVID-19 pandemic. While the future biophysical scenarios are not likely to change, the socio-economic scenarios may due to structural and technical changes resulting from the pandemic. The overall aggregate effect of climate change on economic growth will most likely be negative in the long term.

The rising food inflation in the region since 2019 is partly due to climate change and the poor weather conditions which have reduced agriculture production and put upward pressure on food prices. For instance, droughts and floods in Angola and Madagascar have damaged crop and livestock production, putting more pressure on prices, raising import levels for food, and thereby affecting the current account deficit. Although there will be winners and losers from climate change at varying levels of warming, the impact of rising temperatures will be widespread, in part due to the financial, political, and economic integration of the world's economies. The balance between winners and losers turns increasingly negative as temperatures rise.

Table 2.2 : Percentage change in GDP per year from rising temperatures

Sub-regions	GDP (%change/year)			
	1° C	2° C	3° C	4° C
North	–0.76 ± 0.16	–1.63 ± 0.36	–2.72 ± 0.61	–4.11 ± 0.97
West	–4.46 ± 0.63	–9.79 ± 1.35	–15.62 ± 2.08	-22.09 ± 2.78
Central	–1.17 ± 0.45	–2.82 ± 1.10	–5.53 ± 1.56	–9.13 ± 2.16
East	–2.01 ± 0.20	–4.51 ± 0.34	–7.55 ± 0.63	–11.16 ± 0.85
Southern	–1.18 ±0.64	–2.68 ± 1.54	–4.40 ± 2.56	–6.49 ± 3.75
Whole of Africa	–2.25 ± 1.52	–5.01 ± 3.30	–8.28 ± 5.12	–12.12 ± 7.04

Source: World Meteorological Organization (2020)[25]

[22] IPCC (2022).

[23] Wasko, C., Nathan, R., Stein, L., O'Shea, D. 2021. Evidence of shorter more extreme rainfalls and increased flood variability under climate change. Journal of Hydrology, 603(126994).

[24] Eastern and Western Africa would most likely observe a lower GDP per capita by around 15% by the 2050 under a high-warming scenario while GDP per capita would fall by 5% in Central Africa and 10% for northern Africa.

In addition to the economic impacts on income, global warming at levels of 1.5°C will have strong negative effects on macroeconomic stability, health, food security, water supply, human settlements, and livelihoods of the population. These negative effects will be accelerated with 2°C warming, with far-reaching and long-term impacts. For instance, once it is recognised that climate-extreme events are a permanent feature of the environment, many countries may find it economically unviable to replace capital stock unless future damage can be prevented or if there is an opportunity to move their businesses to safer ground. As businesses attempt to relocate, this could involve a short period of disruption, but the fall in capital investment will affect long-run growth and at worst, cause a permanent loss of capital stock and output.

Key transmission channels are: changes in crop production, water resources, biodiversity and ecosystem, and natural hazards. In turn, the areas which are currently impacted and will be increasingly affected include the agricultural, fisheries, health, energy, and tourism sectors.

Negative effects on crop production

Climate change has an overall negative effect on the yields of major crops due to rising temperature, heat stress, reduced precipitation, and moisture deficits. Major food crops consumed in the Southern African region include millet, rice, sorghum, barley, wheat, potatoes, beans, and maize. The review study by Franke (2021)[26] concludes that higher emission scenarios tend to be associated with stronger falls in yield likely due to severe changes in heat stress and/or rainfall patterns. The interconnectedness between crop yields and the climate system is a key concern for Southern African countries as the stakes are large.

There is evidence that yield losses at mid-century will be approximately 18 percent, a significant figure even if it is lower than the 22 percent foreseen across much of sub-Saharan Africa[27]. Yield losses for South Africa and Zimbabwe could be more than 30 percent. In a meta-analysis and systematic review of the projected impacts of climate change on the yield of eight major crops in Africa, Knox et al. (2012) found mean yield changes of -17 percent for wheat, -5 percent for maize, -15 percent for sorghum and -10 percent for millet across Africa by the 2050s. Future climatic changes will also lead to a shortening of crop and fodder growing periods in Southern Africa by an average of 20% by 2050, resulting in a 40% decrease in cereal yields and a drop in the biomass of cereal used for livestock rearing[28]. The loss of livestock under prolonged drought conditions is also a matter of large concern.

Crop production will also be affected by climate-related drought, floods, extreme temperatures, harsh winds, severe storms, and frost. Indirect climate change effects will also increase, such as cropland inundation, erosion, and salinization caused by sea level rise, altered crop resistance to insect damage, and the unpredictable response of pests and pathogens to climate change[29].

These changes in the climate systems will also lead to a reduction in the area suitable for growing many crops. The Southern Africa region faces a high risk of losing a greater proportion of its productive land due to climate change as 75 percent of its area is already arid or semi-arid[30]. Significant losses of productive land are predicted in mostly arid and semi-arid regions. For example, in Angola, warming will lead to a significant reduction in suitable area to grow beans, cassava, maize and sorghum[31]. Suitable land for maize-based crops could fall up by 86% in Namibia. The situation is worsened since most areas are rainfed agriculture. In countries with a single wet season, crop production takes place during the dry season with irrigation system interventions. Since the cultivated area equipped for irrigation stands at 6.6%[32], severe drought may cause total crop failure[33] and the prospect of growing food insecurity.

Different regions within Southern Africa have different agro-ecological conditions and face different changes in climate systems. The impact of climate change on crops is therefore region- and context specific. Climate impacts will vary by farm types, likely causing economic damage to farmers and national GDP. These differences imply that adaptation costs and/or the costs of no-action will greatly vary within and across countries.

Adverse impact on the agricultural sector

The economic and social implications in Southern African countries of adverse climate change can be disastrous as agriculture is the backbone of many economies, contributing significantly to employment, export, food, poverty reduction, and support to women. Table 2.3 shows the major characteristics of the agricultural sector. First, agricultural land as a percentage of total land is large in all countries, reaching 71%, 80.1%, 70.3% and 79.4% in Eswatini, Lesotho, Madagascar, and South Africa. The contribution varies across countries, being lower in those countries and islands which have diversified their economy (e.g., Mauritius).

In some countries, agriculture has relatively higher importance to the livelihoods of the population. Agriculture stills contributes above 20% of GDP in Madagascar, Malawi, and Mozambique and more than 40% of the employment in Angola, Lesotho, Madagascar, Malawi, and Mozambique. The strong positive relationship between the agricultural productivity and GDP means that the population is relatively more vulnerable to climate impacts (figure 2.2). The climate-related risk on agriculture is even higher for the rural population and women employed in that sector as it is a main source of their livelihoods. Angola, Lesotho, Madagascar, Malawi, Mozambique, Zambia, and

[25] World Meteorological Organization (2019). State of the Climate in Africa 2019. WMO-No.1253. World Meteorological Organization, 2020. The estimates are adapted from Economic growth, development and climate change in Africa, published by the African Climate Policy Centre (ACPC) of the United Nations Economic Commission for Africa (UNECA).

[26] Franke, A. C. (2021) Assessing the impact of climate change on crop production in southern Africa: a review, South African Journal of Plant and Soil, 38:1, 1-12, DOI: 10.1080/02571862.2020.184432

[27] IPCC (2014) (ibid), Ofori SA, Cobbina SJ and Obiri S (2021). Climate Change, Land, Water, and Food Security: Perspectives From Sub-Saharan Africa. Front. Sustain. Food Syst. 5:680924. doi: 10.3389/fsufs.2021.680924

[28] Ofori et al. (2021) Ofori SA, Cobbina SJ and Obiri S (2021). Climate Change, Land, Water, and Food Security: Perspectives From Sub-Saharan Africa. Front. Sustain. Food Syst. 5:680924. doi: 10.3389/fsufs.2021.680924

[29] Müller, C., Cramer, W., Hare, W. L., Lotze-Campen, H. (2011) Climate change risks for African agriculture. PNAS, vol. 108, no.11.

Zimbabwe have a higher percentage of the female employment in agriculture. Agricultural activities are higher prone to many climate-related hazards and uncertainties. Environmental degradation, water scarcity, and pests and diseases are all factors influencing crop production and agricultural activities.

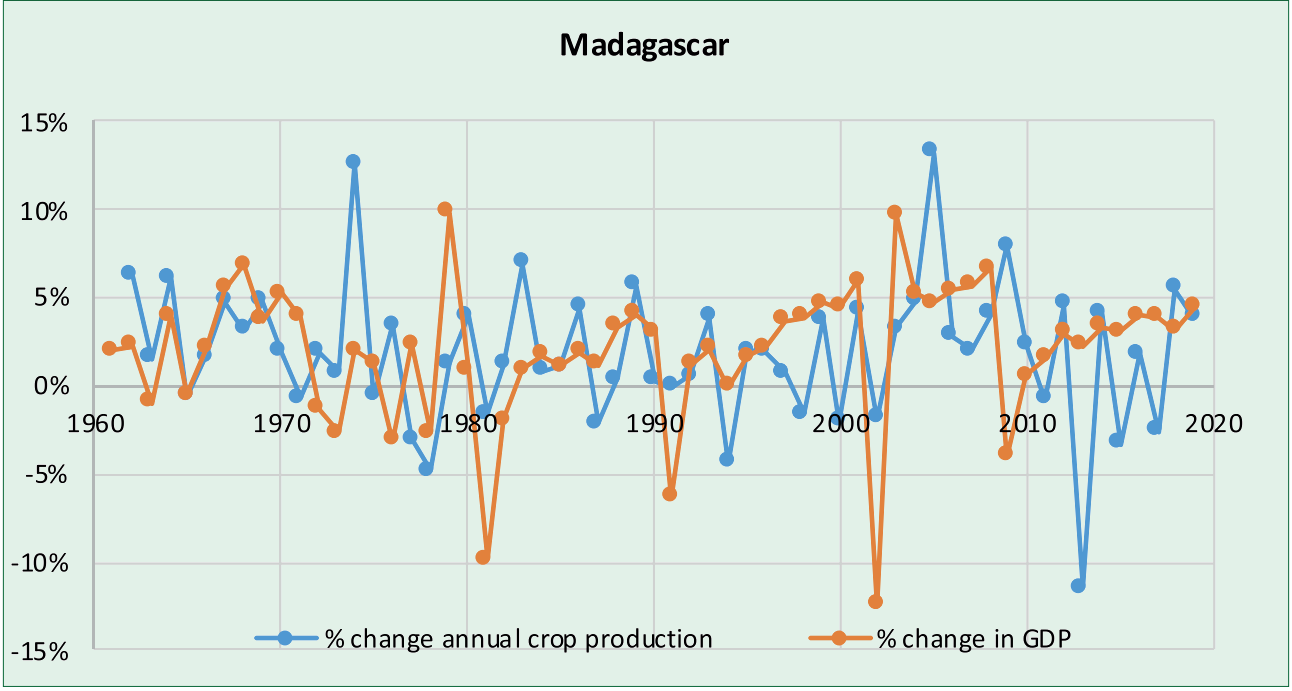
Table 2.3 : Agricultural sector in Southern Africa

Countries	Agricultural land (sq.km)	Agriculture land as % of total land[a]	Agricultural sector as % of GDP (2014-2019)[b]	Employment in agriculture as % of total employment	Employment in agriculture as % of total employment
Angola	569525	45.7	8.6	51.0	57.3
Bostwana	258616	45.6	2.0	20.9	16.3
Eswatini	12220	71.0	8.8	12.9	10.9
Lesotho	24333	80.1	4.6	45.4	41.5
Madagascar	408950	70.3	24.7	65.3	61.4
Malawi	56500	59.9	24.9	76.9	82.6
Mauritius	860	42.4	3.1	6.4	4.5
Mozambique	414138	52.7	23.9	71.1	80.9
Namibia	388100	47.1	7.3	22.1	20.5
São Tomé & Príncipe	440	45.8	11.5	20.2	9.4
South Africa	963410	79.4	2.3	5.4	3.9
Zambia	238360	32.1	4.7	50.8	56.4
Zimbabwe	162000	41.9	9.0	66.5	70.3

[a] 2018
[b] average for the period 2014-2019 (Prior to COVID-19 pandemic)

Source: World Bank Indicators

Figure 2.2 : Crop production and GDP – Madagascar[34]



[30] Turral, H., Burke, J.J., Faurès, J.-M. (2011). Climate Change, Water and Food Security; Food and Agriculture Organization of the United Nations (FAO): Rome, Italy.

Figure 2.2 : Crop production and GDP – Malawi[34]

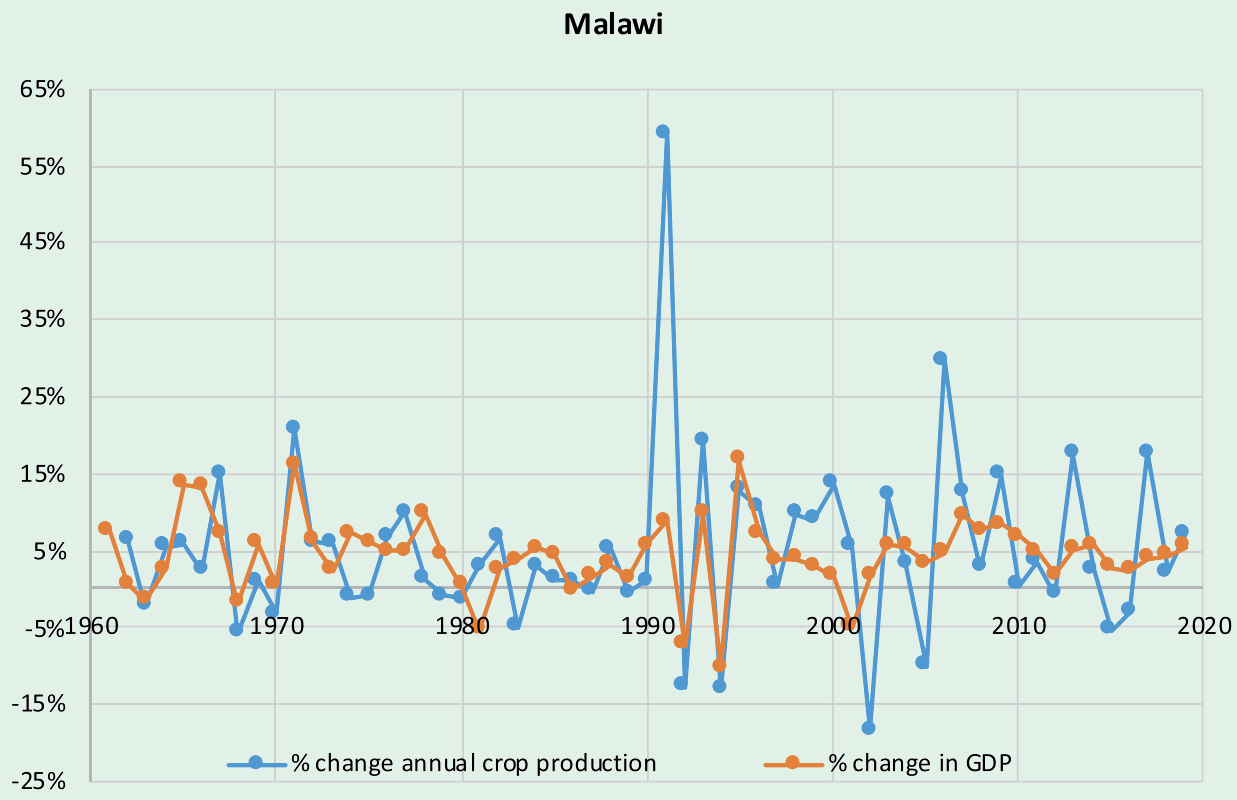
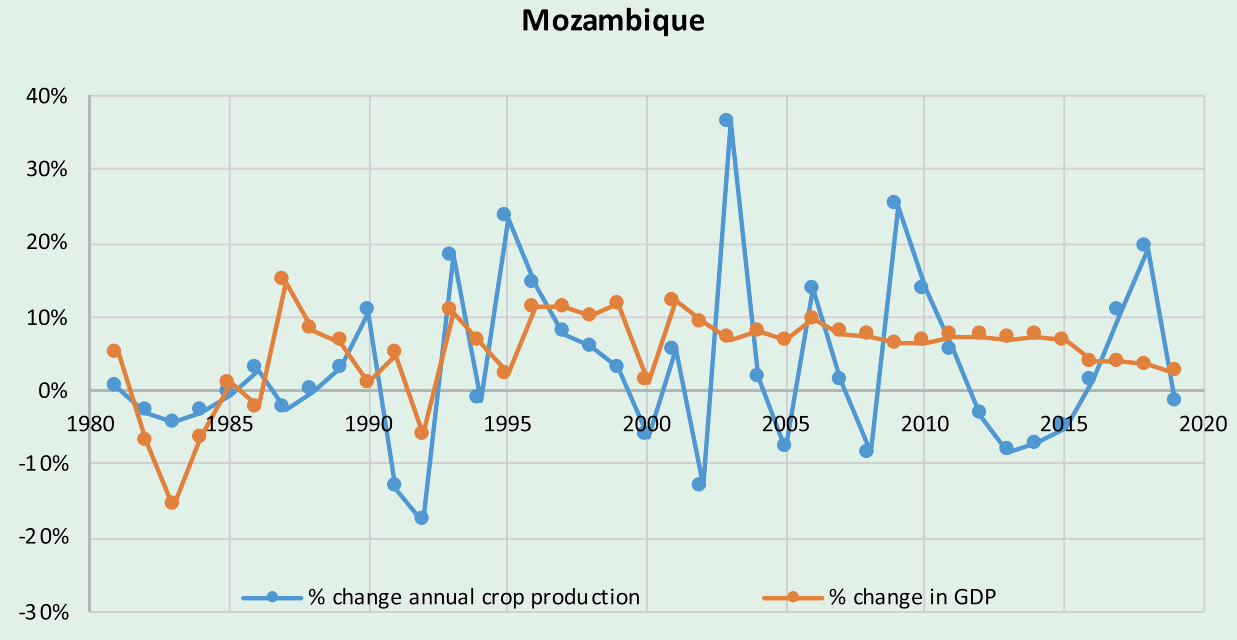


Figure 2.2 : Crop production and GDP – Mozambique[34]



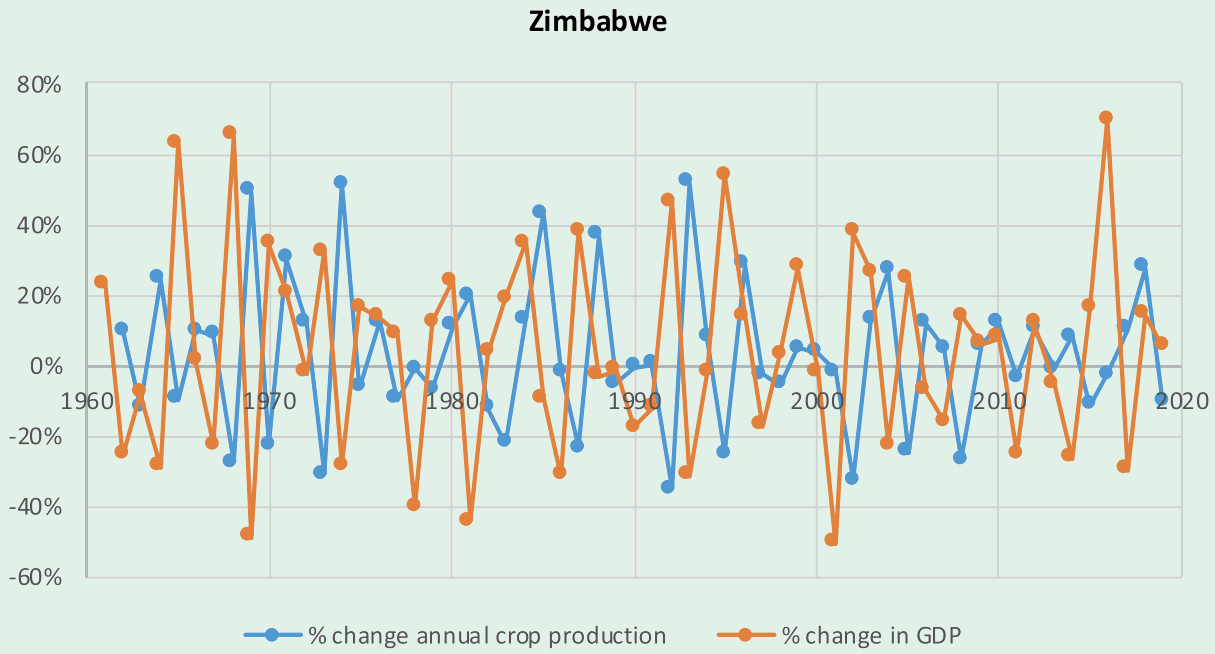
[31] Hunter. R., Crespo. O., Coldrey, K, Cronin, K, New, M. (2020). Research Highlights – Climate Change and Future Crop Suitability in Angola. University of Cape Town, South Africa, undertaken in support of Adaptation for Smallholder Agriculture Programme' (ASAP) Phase 2. International Fund for Agricultural Development (IFAD), Rome

[32] SADC (2014). SADC Regional Agricultural Policy; Southern African Development Community (SADC): Gaborone, Botswana; p. 30.

[33] Davis, C.L.; Vincent, K. (2017). Climate Risk and Vulnerability: A Handbook for Southern Africa, 2nd ed.; CSIR: Pretoria, South Africa, p. 202.

[34] Data from FAO Stats and World Bank Indicators.

Figure 2.2 : Crop production and GDP – Zimbabwe[34]



Small-scale farming dominates the agriculture sector in terms of agricultural land coverage, cultivating about 80% of the agricultural land and contributing about 90% of agriculture produce. With the exception of South Africa, smallholder farmers are mainly producing for their family's subsistence. Surpluses are sold in local markets and the cash used to supplement household needs[35]. Women involved in the agricultural sector will be at risk of falling further into poverty. The use of traditional farming practices does not help them to adapt to climate change, but increases their vulnerability[36]. The multiple feedback loop between extreme weather events, high poverty rates, limited finance, poor infrastructure, and technological constraints mean that the adaptive capacity of the region is low. This situation is not helped by regular exposure to conflicts.

Following a review of reports submitted to the UNFCCC (National Communications and National Determined Contribution (NDC)) and the synthesis of various sources such as the World Bank Climate Change Knowledge Portal, the key impacts of climate change on the agricultural sector which are most likely to determine adaptation needs of the 13 Southern African are provided in Appendix 1.4.

Declining catch potential in fisheries

Several climate variables such as changes in air and water temperatures, precipitation, river flow, nutrient levels, storm frequency and intensity and flooding occurring in marine ecosystems can influence fisheries through a range of direct and indirect pathways[37]. Changes in climate are projected to affect fishery ecosystems through coral reef bleaching, intrusion of saline water into freshwater fisheries and high evaporation in catchment areas, resulting in the altered distribution and quantity of fishery resources. Projected impacts suggest a 10–30% decline in fisheries' catch potential in Southern Africa[38]. Moreover, extreme natural events such as cyclones and flooding have both a direct and indirect impact on fisheries, in terms of damaging fishing infrastructure, lost vessels, fishing gear, and boat engines[39]. Climate change impacts on fishery can also be assessed through their indirect effects on food security, fish-related jobs, and related industries.

The negative impact of climate change on fisheries is likely to have important implications for coastal communities. For instance, 66% of the population live in the coastal zone in Mozambique and 85% of fish are caught by small-scale fishers[40]. A large segment of the population is therefore at risk due to climate change. The fishing sector is also critical in Namibia being a substantial export earner and is the third most important sector in Angola after the oil and diamond industries. In Mauritius, where the artisanal fisheries sector is relatively small, fishers face low alternative employability and lack the skills to make the shift to deep-sea fishing. Consequently, they are more susceptible to reduced income and poverty with the adverse impact of climate change.

Rising threat of food insecurity

Falling production whether of crops, livestock or in fisheries do not only directly affect the livelihoods of those involved in the agricultural. Climate change will impact on crucial dimensions of food security such as access to food, stability of supply and accessibility, and the degree to which food is nutritious and healthy and can therefore be safely consumed.

[35] Khumalo, T. 2021. Chapter 11: Social Issues related to climate change and food production. The Impacts of Climate Change. Elsevier Inc. https://doi.org/10.1016/B978-0-12-822373-4.00012-4.

[36] Lötter, D. 2017. (ibid).

[37] Rodney. T. Muringai , Paramu. L. Mafongoya & Romano Lottering (2021): Climate Change and Variability Impacts on Sub-Saharan African Fisheries: A Review, Reviews in Fisheries Science & Aquaculture, DOI: 10.1080/23308249.2020.1867057

[38] IPCC (2022), pp 9-19.

The risk of food insecurity resulting from climatic hazards is already being observed in Southern Africa, particularly in rural settlements. Global projections suggest that the number of people at risk of hunger will increase by 10 to 20 percent by 2050 because of climate change, with 65 percent of this population living in sub-Saharan Africa.

Table 2.4 shows the high prevalence of severe food insecurity for the countries in this region. With the exception of Mauritius, all suffer substantially from severe food insecurity, with a percentage higher than 30% in Malawi, Mozambique, Zimbabwe and Eswatini. Data for Madagascar is not published in the World Development Indicators - the main data source in table 2.5.- however, the island suffers severe food insecurity[41]. Because the agriculture sector is the backbone of many countries, providing livelihoods and food for the most vulnerable (e.g. in Madagascar, Malawi and Mozambique), the transmission channel connecting climate-related hazards, crop failures, and food insecurity seems clear.

In 2018–2019, following the poor rainfall season in the southern half of Zambia, crop production declined, causing poor food access and availability. Almost 39% of households had food for only six months[42]. Government and food security partners like the United Nations International Children's Emergency Fund (UNICEF) and World Food Programme (WFP) provided pulses and emergency cash transfers to more than 66,000 households in affected regions, including WFP's launch of the early recovery and resilience programme targeting 104,000 smallholder farmers in five of the 58 districts affected by drought in the 2018–2019 season. Madagascar has also witnessed many episodes where international food aid was needed to supplement yield deficits.

The situation is even more complex when considering the rising demand for food in the region. In its latest report on food systems in Africa[43], the World Food Programme highlights several key drivers of food systems for the next 25 years, namely urbanisation, population growth, and rising income. Consequently, demand for food crops is expected to rise. The agricultural sector therefore needs to produce enough food for the current and future population to meet its future requirements. This is likely to increase the demand for rural producers, fuelling development prospects such as labour, processing and manufacturing units and agro-food value chains.

Table 2.4 : Food insecurity and undernourishment in 13 Southern African countries

Countries	Prevalence of severe food insecurity in the population (percent)	Prevalence of severe food insecurity in the population (percent)
Angola	26.9	17.3
Bostwana	22.2	29.3
Eswatini	30.8	11.6
Lesotho	27	23.5
Madagascar	n.a	43.2
Malawi	51.4	17.3
Mauritius	8.3	6.2
Mozambique	40.5	31.2
Namibia	32.1	19.8
São Tomé & Príncipe	n.a	11.9
South Africa	19.3	6.5
Zambia	23.2	n.a
Zimbabwe	32.1	n.a

Source: World Bank Indicators

[39] Muhala V, Chicombo TF, Macate IE, Guimarães-Costa A, Gundana H, Malichocho C, Hasimuna OJ, Remédio A, Maulu S, Cuamba L, Bessa-Silva AR and Sampaio I (2021) Climate Change in Fisheries and Aquaculture: Analysis of the Impact Caused by Idai and Kenneth Cyclones in Mozambique. Front. Sustain. Food Syst. 5:714187. doi: 10.3389/fsufs.2021.714187

[40] SADC Fisheries Fact Sheet, Volume 1, No. 1, January 2016.

[41] International Federation of the Red Cross and Red Crescent Societies. 2020. Madagascar: Food Insecurity - Final Report, DREF n° MDRMG017 https://-reliefweb.int/sites/reliefweb.int/files/resources/MDRMG017dfr.pdf

[42] Zambia Disaster Management and Mitigation Unit (DMMU), 2019–2020. Humanitarian Appeal 2019-2020 Zambia.

However, this reality is constrained by many climate-related impacts (such as crop failures, falling production and suitable agricultural land). Southern Africa is not producing enough food to adequately provide for the needs of its present population, despite the huge investments in agriculture. Moreover, while necessitating improvements in the food system (production, processing and manufacturing, distribution, markets, consumption, and food waste), the rising demand for agricultural land will have negative impacts on deforestation, soil degradation and CO_2 emissions. The challenge for the Southern Africa countries is to implement adequate socio-ecological climate change adaptation strategies in the agricultural sector to protect livelihoods, shift to high productivity activities, and ensure food security for the population.

Growing risk of water crisis

Water remains at the very centre of projected climate change impacts, having both direct and indirect effects on socio-economic environments. Even without climate change, rainfall exhibits extreme variability in time and space over Southern Africa[44]. While there is significant uncertainty on the magnitude of climate change impacts, the most probable scenario indicates a decrease in rainfall in the interior of Southern Africa by 2050, especially during the all-important growing season.

There are 14 major river basins in the Southern African region. All of them are transboundary basins, extending into more than one country[45]. The review by Kusangaya et al. concludes that a general decrease in streamflow is inevitable for several basins by 2050 as a result of reduced rainfall and increased evaporation: Eswatini's streamflow would decrease by up to 40%; the Pungwe catchment by up to 75%; the Limpopo catchment up to 35%; the Thukela catchment in South Africa up to 18%; the Okavango in Botswana up to 20%; the Zambezi, Limpopo, Ruvhuma and Orange catchments up to 45% decrease, and the Gwayi, Odzi and Sebakwe catchments in Zimbabwe by up to 50%. Some catchments were projected to experience increases in streamflow such as parts of the Thukela catchment in South Africa of between 16% and 38% which could lead to flooding.

Water scarcity will have important effects on the well-being of the population. The Cape Town drought episode is one recent example, identified as the worst drought since the 20th century in South Africa. It started in 2015 and persisted until 2018, leading to the "Day Zero" water crisis. The town became the first major world city to run out of water, leaving its almost 4 million population with extreme water restrictions on showering and half a gallon of daily drinking water per person[46].

Falling precipitation will also have an impact on water quality. Climate change (and increasing demands) results in further reduction in runoff, causing an increase in the concentrations of nutrients with the reduced flows of the river. This is currently being observed in the Berg River Dam in South Africa as an example[47]. The low quality of water available for irrigation poses an increasing risk to agricultural crops and ultimately to human health, which affects the level of compliance recommended by international standards with microbial pollutants, and therefore poses a concern for crop exports. The case of the Berg River Dam further demonstrates that the reduced quality of the irrigated water affects crops yields and exports and further affect the financial flows to the local and national economy. The worsening water scarcity represents an important challenge for Southern African countries as there is a large part of the area, which is arid (75%), and where annual rainfall is less than 650 mm[48].

The impact of climate change on streamflow places the region at the centre of a climate-water-food nexus. Increased warming conditions would increase the water demand needed for agriculture (particularly irrigation agriculture) on already stressed water resources systems. Agriculture is already the largest water consumer in the region. Twenty-five percent of cultivated land is under water management (non-equipped flood recession cropping area and non-equipped cultivated wetlands and inland valley bottoms) and the remaining land is under rainfed[49]. Many countries already face water deficits which impede the ability to meet the needs of the agriculture sector. Higher water temperatures will increase the rates of evaporation, reducing the volume of water needed for both dryland and irrigated agriculture. The increased demand for water in agriculture will aggravate water, energy, and food insecurity as was experienced during the 2015/16 drought.

Increasing intensity and frequency of natural hazards

Natural hazards including floods, drought, frost, strong winds, and heavy snowfall impacted on many sectors such as agriculture and livestock, water, tourism, and health. The impacts of extreme rainfall events on public and private infrastructure have resulted in costly repairs, road closures, limited or lack of access to electricity, and complete failures of sewage and storm water systems[50]. Agricultural output is affected by extreme events (mainly droughts and floods) and extreme variability in climatic resulting in both direct short-term and long-term impacts on the overall sector performance.

The intensity and frequency of extreme droughts and floods has increased in recent years across the Southern Africa region, and these conditions are only expected to worsen in the future. Flooding is the more frequent of the two extreme events, occurring at an average of once in every two years, with Malawi, Mozambique, Zambia, Zimbabwe, and Madagascar being the most affected. Recent hailstorms, heavy rains, and flash floods in Lesotho have resulted in significant damage to houses, vehicles, roads, schools, and health centres as well as key crops, maize, beans, and sorghum. The access to food and stability of supply are

[46] Dey, R., and Lewis, S. C., 2021. Natural disasters linked to climate change. The Impacts of Climate Change. Elsevier Inc. https://doi.org/10.1016/B978-0-1

[47] Cullis, J.D.S., Horn, A., Rossow, N., Fiisher-Jeffes, L., Kunneke, M. M., and Horrman, W. 2019. Urbanisation, climate change and its impact on water quality and economic risks in a water scarce and rapidly urbanising catchment: case study of the Berg River Catchment. H2Open Journak. Vol.2. No.1doi: 10.2166/h2oj.2019.027. pp.146-167.

[48] Nicholson, S.E.; Funk, C.; Fink, A.H. Rainfall over the African continent from the 19th through the 21st century. Glob. Planet. Chang. 2018, 165, 114–127.

[49] Nmachena et al. 2020.

[50] Kamara, J., Agho, K. and Renzaho, A. (2019). Understanding disaster resilience in communities affected by recurrent drought in Lesotho and Swaziland – a qualitative study. PLOS ONE. DOI: https://doi.org/10.1371/journal.pone.0212994

closely linked to the conditions of the infrastructure which transportation (roads, railways, cargo transfer) and storage system. The infrastructure is affected by extreme weather events (e.g. flooding and droughts) which destroys a significant component of trade and transport systems as well as increasing heat stress.

The El Niño–Southern Oscillation (ENSO) and sea surface temperatures are considered key factors influencing drought[51]. Between the period of 2011 to 2020, countries like Madagascar and Lesotho have experienced poor rains and regular periods of droughts leading to poor agricultural harvests, loss of livestock, an increase in food prices, starvation, food shortage, famine, drying up of reservoirs and dams, which has affected millions of vulnerable people. Box 2.1 provides the consequences of drought episodes in Eswatini, Lesotho, Madagascar and Malawi during last decade.

Box 2.1 : Socio-economic consequences of drought in Southern Africa

Eswatini
Eswatini's annual assessment by the Swaziland Vulnerability Assessment Committee indicated that 116,000 people (10 percent of the population) faced a food deficit during the 2012/2013 lean season. This was a 30 percent increase on the 2011/12 figure of 89,000. The country subsequently experienced a severe drought during the 2015/2016 season caused by the El Niño Oscillation (ENSO). Rainfall decreased by over 50% and water sources also declined by more than 50% affecting portable water in both rural and urban areas, including health facilities and schools.

The agricultural sector and agribusiness were badly affected with a reduction of 30% in revenue for sugarcane and 80% for vegetable production. Maize production reduced by 64% compared to the previous season and by 63% compared to the previous five-year average. Between 2014 and 2016, the country was also affected by a fall army worm invasion that affected crops such as maize, sorghum, soybeans, groundnuts, and potatoes, and worsened agricultural productivity. By 2016 about 80% of cereal was imported which led to an increase in the price of maize, even though the price had been generally falling in the Southern Africa region. The drought caused the death of 63,000 cattle and the food insecure population was understood to be 275,274 and the population lacking livelihoods was believed to be 550,744 during the 2016/17 year. Household food pressure also led to a range of social problems including an increase in gender-based violence in communities and a reduction in children's education. Schools were required to provide meals to pupils to support improved food security among the most vulnerable.

The Vulnerability Assessment and Analysis (2019) for the 2019/20 period included an evaluation of key issues such as agriculture, health, nutrition, and education. This assessment reported that more than 20% of the rural population had experienced severe acute food insecurity, with 14.2% indicating that in recent months they had faced moderate hunger whilst 8.5% were faced with severe hunger. Dietary patterns show a high reliance on maize and other starches, but low consumption of fruits, vegetables, milk, and meat. Household diet diversity had deteriorated and 23% of the population reported their diet was unacceptable.

Lesotho
Drought is also a recurring hazard, which results in disasters for communities and the wider economy in Lesotho. Lesotho's drought from 2015 to 2017 had dramatic impacts to the country's food security situation and required food assistance from international donors.

Madagascar
Madagascar is one of the ten countries most vulnerable to disasters worldwide and is the most cyclone-exposed country in Africa. The impact of severe El Niño-induced drought on crop production in southern Madagascar, where nearly 850,000 people are acutely food insecure, is likely to persist and requires an intensified humanitarian response. The lack of sufficient rains in the southern region of Androy alone resulted in an 80 percent decline in maize production compared with the already reduced levels of 2015. Prolonged drought also seriously affected the production of another staple food, cassava, in both Androy and another southern region, Atsimo-Andrefana, where cassava production dropped by approximately half. People living in these areas have been hit by successive droughts over the last few years and their hunger situation is expected to remain severely stressed. Some 1.5 million people are estimated to be food insecure in 2021 in Madagascar's three southern regions of Androy, Anosy and Atsimo-Andrefana. Of these, around nearly 850,000 are acutely food insecure.

Malawi
In Malawi, droughts have been observed to increase poverty by 1.3 percentage points, but this rises to almost 17 percentage points during a 1-in-25-year drought (roughly equal to an additional 2.1 million people falling below the poverty line). Children, the elderly, and female-headed households tend to suffer the most from droughts through malnutrition and consequential high susceptibility to diseases. In addition, livestock and wild animals are adversely affected by drought. Urban households as well as those engaged in off-farm activities will also continue to suffer from droughts due to higher food prices and declining non-farm wages.

Source:
Swaziland Drought Assessment Report Rapid Assessment 2015/2016 Season. Deputy Prime Minister's Office. https://www.humanitarianresponse.info/sites/www.humanitarianresponse.info/files/documents/files/swaziland_rapid_assessment_summary_report_2016.pdf
Phungwayo, T., Kushitor, S. B. and Koornhof, L. 2021. Governance of food and nutrition security in Eswatini: an analysis of government policies and reports. Agriculture & Food Security, vol. 10, no. 45.

Projections indicate an increase in the frequency and intensity of flooding in the coastal zone of Angola in all seasons, except in the winter months of June, July and August, interspersed with longer periods of drought[52]. Cyclone intensity is expected to increase significantly, for example, in Madagascar the strength of cyclones may increase as much as 46% with a northward shift. The implications for agriculture output, food security, and infrastructure are catastrophic. The episodes of several tropical cyclones such as Cyclone Idai in March 2019 and Ana in 2022 provide ample evidence of the potential impacts. Box 2.2 provides a brief account of the impacts of the tropical cyclones during the last five years.

Given the underlying constraints on public finances, extreme weather events and shocks will mean further financial challenges for the Southern African countries.

Box 2.2 : Tropical storms in Southern Africa

The scientific link between tropical storms and climate change has been well established. Increases in average global temperatures will result in increased precipitation, atmospheric moisture, and circulation, which combined with sea surface warming, will increase the frequency and intensity of storm activity. In recent years, rainy seasons have been characterized by heavy rains, hailstorms and floods. For island states such as Madagascar, Mauritius, and São Tomé & Príncipe in the Indian Ocean, geographic predisposition reinforces their vulnerability.

The Southern Africa region is expected to witness more high-impact tropical cyclones, coastal flooding and intense rainfall linked to climate change. Table A shows the number of people affected and death toll for Madagascar, Malawi, Mozambique and Zimbabwe over the last five years. In January 2022, tropical storm 'Ana' affected all four countries as it passed through Madagascar, before moving towards Mozambique and Malawi, bringing torrential rains. It subsequently headed towards Zambia and Zimbabwe. The death toll went as high as 58 for Madagascar, 53 in Malawi and 38 for Mozambique. In northern and central Mozambique, Ana destroyed 10,000 homes and dozens of schools and hospitals[a]. Just week later, Madagascar faced the toll of Batsirai in February 2022, which left 121 people dead, according to official figures, and destroyed many buildings and roads[b]. Madagascar's geographical disposition with long low-lying stretches of coastal areas makes it more susceptible to storm damage. Over 60% of tropical cyclones that develop in the Indian Ocean affect Madagascar.

Two years ago, the damage of Cyclone 'Idai', labelled as one of the worst weather-related catastrophes in the history of Africa, was disastrous in Mozambique, Zimbabwe and Malawi, causing a huge humanitarian crisis. Malawi was struck by Cyclone Idai which first devastated Mozambique before making landfall in the southern region of Malawi, impacting at least 13 districts. More than 29,000 households were affected by the floods and displaced. The absolute losses to Mozambique and Zimbabwe were USD (PPP) 4.9 billion and USD 1.8 billion respectively. Similarly, the flood damage in Mozambique caused by tropical storms Elyne and Gloria in February and March 2000 was estimated at USD 1 billion, compared with the country's export earnings of only $300 million in 1999. The Global Climate Risk ranked Mozambique and Zimbabwe as the world's top countries affected by climate externalities[c].

In a study on the economic vulnerability and damage costs of tropical storms, Molua, Mendelsohn, and Kamind conclude that Madagascar suffers the biggest costs for damage in today's climate, reaching $139m with an impact averaging 0.002% of GDP, followed by Mozambique. Moderate damage was observed in Mauritius, whilst Mozambique with significant primary commodity economies, incurs maximum damages at $49m. South Africa is the most resilient, incurring lower damages. Mauritius and Mozambique suffer the most consistent effects while Madagascar, Mozambique and South Africa are projected to be persistently damaged by warming. By 2100, damages in Mozambique and Mauritius are expected to rise by 0.00026% and 0.00138% of GDP. Madagascar is likely to be the most seriously affected, with hurricane damages projected to reach $36m per year by 2100 while Mozambique and Mauritius are hit by mean annual damages worth $23m, and $4m, respectively.

Table A : Tropical storm and cyclones in Southern Africa 2018-2022[e]

	Madagascar		Malawi		Mozambique		Zimbabwe	
	Death	Total Affected	Death	Total Affected	Death	Total Affected	Death	Total Affected
Cyclone 'Ava' (2018)	73	161318	-	-	-	-	-	-
Tropical storm 'Eliakim' (2018)	21	50872	-	-	-	-	-	-
Cyclone 'Belna' (2019)	5	20293	-	-	-	-	-	-
Cyclone 'Idai' (2019)	3	1100	-	-	603	1501500	628	270186
Cyclone 'Herold' (2020)	4	3200	-	-	-	-	-	-
Tropical cyclone 'Eloise' (2021)	2	1000	-	-	11	481901	3	2400
Cyclone 'Emnati' (2022)	15	169583	-	-	-	-	-	-

Tropical storm 'Ana' (2022)	58	131000	53	110958	38	185636	-	3000
Cyclone 'Batsirai' (2022)	94	116000	-	-	-	-	-	-
Tropical storm 'Dumako' (2022)	6	9900	-	-	14	23733	-	-
Tropical cyclone 'Gombe' (2022)	2	900	7	-	63	736123	-	-
Cyclone 'Kenneth' (2022)	-	-	-	-	45	400094	-	-

Source:
a- *https://www.theguardian.com/world/2022/jan/28/dozens-killed-in-tropical-storm-ana-as-southern-africa-braces-for-more-wild-weather*
b- *https://abcnews.go.com/International/wireStory/madagascar-southern-africa-brace-tropical-storms-82875949*
c- *Eckstein, D., Künzel, V., and Schäfer, L. 2021. Global Climate Risk Index 2021 Who Suffers Most from Extreme Weather Events? Weather-Related Loss Events in 2019 and 2000-2019. Briefing Paper, Germanwatch downloaded at: https://germanwatch.org/sites/default/-files/Global%20Climate%20Risk%20Index%202021_1.pdf [accessed on the 6th April 2021)*
d- *Molua, E.L., Mendelsohn, R.O. & Akamin, A., 2020, 'Economic vulnerability to tropical storms on the southeastern coast of Africa', Jàmbá: Journal of Disaster Risk Studies 12(1), a676. https://doi.org/10.4102/ jamba.v12i1.676*
e- *Data from EM-DAT The international disasters database*

Vulnerability of coastal areas due to climate change

The coastal areas of Southern Africa are vulnerable to extreme inshore water levels and flooding as a result of sea level rise, as well as a combination of extreme events such as sea storms during high tides . There are severe consequences of rising sea levels along Southern African coasts including flooding, intrusion of salt water, reduced resilience of corals, and loss of beaches. Sea level rise will also affect coastal biotopes, such as mangroves, increasing salinity and making the survival of plant species impossible or altering the local flora. The destruction of coastal fisheries and infrastructure is likely to cause loss of livelihoods and displacement of people. For example, infrastructure in Angola is concentrated in coastal areas and the threat of sea level rise is faced by its coastal population, representing 50 percent of Angolans . Mozambique's projected floods in low-lying areas will imply a higher number of vulnerable populations.

Growing health risks

There is a strong empirical relationship between vector survival and temperature. For example, the growth of mosquitos and the frequency with which they feed on blood is influenced by the temperature. Mosquitos transmit a wide variety of serious microbial diseases to humans through their bites, including malaria, dengue fever, Chikungunya virus, yellow fever, zika virus, and West Nile virus, as well as numerous other diseases . For this reason, small changes in temperature and rainfall can influence the range of mosquitos and global warming has already expanded the range of mosquitos to higher altitudes and latitudes. As the temperature has increased, malaria has become common in high mountain villages in Africa and exposure to malaria transmission is also expected to increase in previously unsuitable regions. The IPCC (2022) report further confirms that the distribution and seasonal transmission of vector-borne diseases is expected to increase over Southern Africa as people are exposed to mosquito-borne arboviruses.

In a study published by the Malaria Journal[56], the high risk of malaria transmission is highlighted for those regions in the higher elevation regions of Southern and Eastern Africa. Countries likely to be impacted in future by the spread of mosquitos include northern Angola, southern DRC, western Tanzania, and central Uganda in 2030; by 2080 these changes are predicted to extend into western Angola, the upper Zambezi River Basin, and north-eastern Zambia, and will become more concentrated along the East African highlands. RCP 4.5 and RCP 8.5, across three future time horizons of 2030, 2050, 2080, show that between 196 million and 198 million people in Eastern and Southern Africa are predicted to be burdened by increased transmission risk in the future by the 2080s. Regionally, by the year 2080, the worst-case scenario (RCP 8.5) predicts an additional 73.4 million people at risk from year-round exposure to viral serious transmission in Eastern Africa[57].

Flooding can contaminate fresh water supplies with sewage, which increases pathogens like Salmonella bacteria and cholera in drinking water which may kill many people. Drought can also have huge negative impacts on health and spiral into wider vulnerability. In Eswatini, the 2015/16 El Niño induced drought had led to a deterioration of health in many households and it was observed that such households were three times more likely to be food insecure during a drought than households without health or disability impacts[58].

[51] Masih, I., Maskey, S., and Trambauer, P. (2014). A review of droughts on the African continent: a geospatial and long-term perspective. Hydrol. Earth Syst. Sci., 18, 3635–3649. doi: 10.5194/hess-18-3635-2014worsened

[52] INDC, 2021.

[53] Davis-Reddy, C.L. and Vincent, K. 2017: Climate Risk and Vulnerability: A Handbook for Southern Africa (2nd Ed), CSIR, Pretoria, South Africa.

[54] https://climateknowledgeportal.worldbank.org/country/angola

[55] Maloy, S. 2021. Climate change and microbes. Chapter 7. The Impacts Of Climate Change A Comprehensive Study Of Physical, Biophysical, Social, And Political Issues. Ed. Trevor M. Letcher.

[56] Ryan, S., Lippi, C. A., Zermoglio, F. 2020. Shifting transmission risk for malaria in Africa with climate change: a framework for planning and intervention. Malaria Journal, vol. 19, no. 170.

[57] Ryan, S., J., Lippi, C. A., and Zermoglio, F. 2020. (ibid).

Crop pests are already a major concern influencing farm productivity. Globally about one-sixth of field production is lost to pests, with further losses occurring in storage. As the climate changes it is expected that the prevalence of crop pests will also alter, with more frequent new pest introductions, the occurrence of major pest outbreaks, and the risk of pesticide residues in food will as a result increase[59]. In Lesotho, more than 90 percent of disasters are related to climate variability and change, specifically, drought, snowfall, hailstorms, strong wind, localized floods, and early frost and pest infestations[60]. Recent episodes also include the Masvingo district in Zimbabwe which has been attacked with crop pests such as armyworms[61]. Metaanalyses suggest that around 20 percent of ruminants in Africa and more than 50 percent of poultry die prematurely each year, with case studies suggesting at least half of these deaths are due to infectious disease. Climate change can exacerbate disease in livestock, and some diseases are especially sensitive to climate change. Among 65 animal diseases identified as most important to the animals poor people rely on, 58 percent are climate sensitive.

To deal with the issue of pests, weeds and diseases in farms, farmers are forced to make use of pesticides, weedicides, herbicides, or fungicides. The improper handling of these chemicals by farmers and other end users has been responsible for their high levels occurring in freshwater and terrestrial ecosystems, posing threats to both human health and the ecosystem at large.

Rising threats of unplanned migration and human settlement

Unplanned migration is likely to take unprecedented upswings due to the increasing risks of reduced precipitation, increasing frequency of floods and intensity of tropical cyclones, continued desertification, and depletion of fisheries[62]. Migration trends indicate that South Africa (with 2.4 million) and Zimbabwe (with 361,000) already absorb the largest number of migrants in the 13 Southern African countries[63]. There is evidence of migration in the water-food-socio-economic nexus, as migration will occur away from water-scarce regions. As men are more likely to migrate from water insecure regions, women are often left behind without an adequately supportive social infrastructure and facing the risk of falling into poverty. As populations migrate to urban regions congregating in informal settlements, the threat of food insecurity and under-nourishment is likely to be widespread.

Increasing conflicts, antisocial behaviour and violence

Many studies highlight a possible relationship between temperature, water scarcity and societal conflicts within Africa, often manifesting as antisocial behaviour and violence. Warming trends since 1980 have elevated conflict risk in sub-Saharan Africa by 11 percent and climate change has been estimated to increase conflict risk across the region by 54 percent by 2030[64]. For instance, the Second National Communication in Lesotho highlighted the existing tensions between agricultural and livestock producers as well as the human population needs for water, especially during the dry season. Transboundary water management must be carefully and collaboratively planned to avoid any potential conflict and maintain an equitable, sustainable availability of water.

Disproportionate impacts on women

Climate change has a disproportionate impact on women. Analysis of death tolls from natural disasters indicate that women are 14 times more likely than men to die[65]. This is mainly because women are more vulnerable as they are more likely than men to be living in poverty, engaged in low-paid and low productivity activities with a lack of security and benefits. Their poorer health, nutrition, and living and working conditions exacerbate their difficulty and reduces their resilience to shocks. Low-income women and female-headed households have often been singled out as being the most vulnerable to climate change as they are poorly equipped to make interventions to slow change or even make the necessary adaptations. In a study by Flato et al. (2017) in South Africa, female-headed households are found to be particularly vulnerable due to climate variability because of their limited access to protective social networks or other coping strategies[66].

Specific areas of disparity in relation to adaptation include women's limited access to and control of land, high household work burdens that include the responsibility for water and fuelwood collection, high levels of responsibility for agricultural production and lack of access to formal education[67]. Disparities in wage and employment are other important facets of vulnerability while socially- ascribed roles also limit their participation in climate change initiatives[68]. Access to climate information, such as weather forecasts, has been identified as a potential enabler for improved adaptation, but such access tends to be strongly gendered[69]. In Malawi for instance, women's preferences are to obtain forecasts through an organisation such as an NGO, or community leaders.

The problems of climate change compound these additional challenges faced by women farmers. While they dominate agricultural labour contributions, women do not have the same access to markets and credit as men. Women receive less than ten percent of available credit and seven percent of credit extension services. This is in part because women, while making up a large proportion of the agricultural labour force, tend to be involved in informal sectors, where their contributions are not recorded in an official capacity[70]. The inclusion of data on non-market production and provisioning activities would likely increase women's participation in economic activity, particularly in agriculture. The undercounting of women in agriculture also arises from the prevalence of multiple jobs among women.

[58] Mohammed, M. and Dlamini, T. 2018. Predictors of food insecurity in Eswatini: Lessons from the 2015/16 El Niño induced drought. African Review of Economics and Finance, vol. 10 , no.2, pp.69-96.

[59] Dhanush Dinesh, Bernard Bett, Randall Boone, Delia Grace, James Kinyangi, Johanna Lindahl, Chadag Vishnumurthy Mohan, Julian Ramirez-Villegas, Timothy Robinson, Todd Rosenstock, Julian Smith and Philip Thornton.

[60] World Bank (2011). Post Disaster Needs Assessment Heavy Rains 2010/2011. URL: https://www.recoveryplatform.org/assets/ publication/PDNA/CountryPDNAs/Lesotho_Heavy%20Rain_2010_PDNA.pdf.

[61] Kumally (2021), pp304.

[62] Mpandeli, S., Nhamo, L., Hlahla, S., Naidoo, D., Liphadzi, S., Modi, A. T., and Mabhaudhi, T. Migration under Climate Change in Southern Africa: A Nexus Planning Perspective. Sustainability 2020, 12, 4722; doi:10.3390/su12114722

[63] The Democratic Republic of the Congo (447,000) ranked second.

Climate change affects the factors which are most essential to women's means of subsistence—food, water and energy. Climate change can alter the allocation of tasks and time in different ways for men and women. Observations showed that there was an increase in distances travelled by women to fetch water owing to a depleted water table, for example in Zimbabwe[71]. Consequently, less time can be devoted to the preparation of meals to ensure adequate nutrition, agriculture or income-generating activities, which in turn affects the household's food security and nutritional wellbeing[72].

2.1.3. Southern Africa's energy sector

Tackling climate change will require a development pathway which facilitates an energy transition, guided by comprehensive sustainable policies and climate-compatible projects. Access to energy is imperative to permit structural change and to achieve economic, environmental and social goals in the Southern African countries.

Low access to electricity – a real challenge

Sustainable development goal (SDG) 7 targets affordable, reliable, sustainable and modern energy for all by 2030. However, this represents a real challenge for Southern African states with the recent rates of growth in electricity access[73]. Table 2.5 shows that only Mauritius among the thirteen countries has universal electricity coverage. While the size of the island facilitated coverage, the participation of independent power producers in the private sector, and legal and institutional reforms over the last decades were the main drivers for ensuring a continuous electricity supply in Mauritius (Box 2.3). Elsewhere in the region, the percentage of the population with access to electricity exceeds 75 percent in only three countries: Eswatini, São Tomé & Príncipe and South Africa. Access to electricity is only available for 11 percent of citizens in Malawi. The level of electricity access is also at odds with the per capita income of countries such as Botswana and Namibia.

Table 2.5 : Access to electricity in Southern Africa

Countries	Access to electricity			Access to clean fuels and technologies for cooking
	% of the population	% of rural population	% of urban population	(% of population)
Angola	45.7	..	72.4	48.7
Bostwana	70.2	27.6	88.3	53.8
Eswatini	77.2	72.9	90.6	52.1
Lesotho	44.6	32.2	75.8	38.4
Madagascar	26.9	..	79.5	0.8
Malawi	11.2	4.1	45.5	2.0
Mauritius	100.0	100.0	100.0	100.0
Mozambique	29.6	4.9	72.5	4.5
Namibia	55.2	35.0	74.6	45.6
São Tomé & Príncipe	75.2	68.5	77.6	2.8
South Africa	85.0	79.2	87.9	85.5
Zambia	43.0	13.9	79.9	15.7
Zimbabwe	41.1	20.1	85.4	29.8

[64] Filho, L. W. Totin, E., Franke, J. A., Andrew, S. M., Abubakar, I. R., Azadi, H., Nunn, P. D., Ouweneel, B., Williams, P. A., Simpson, N. P.2022. Understanding responses to climate-related water scarcity in Africa. Science of the Total Environment, vol. 86 150420.

[65] AfDB (2011). The Link Between Climate Change, Gender and Development in Africa. The African Statistical Journal, Vol. 12 (May), pp. 119-140.

[66] Flato, M., Muttarak, R., and Pelser, A. 2017. Women, Weather, and Woes: The Triangular Dynamics of Female-Headed Households, Economic Vulnerability, and Climate Variability in South Africa. World Development Vol. 90, pp. 41–62.

[67] Rao, N., Lawson, E. T., Raditloaneng, W. N., Solomon, D., and Angula, M. N. (2019) Gendered vulnerabilities to climate change: insights from the semi-arid regions of Africa and Asia, Climate and Development, 11:1, 14-26, DOI: 10.1080/17565529.2017.1372266.

[68] Nyahunda, L. and Tirivangasi, H.M. (2022), "Adaptation strategies employed by rural women in the face of climate change impacts in Vhembe district, Limpopo province, South Africa", Management of Environmental Quality, Vol. ahead-of-print No. ahead-of-print. https://doi.org/10.1108/MEQ-09-2021-0207.

[69] Henriksson, R., Vincent, K., Archer, E., and Jewitt, G. (2021) Understanding gender differences in availability, accessibility and use of climate information among smallholder farmers in Malawi, Climate and Development, 13:6, 503-514, DOI: 10.1080/17565529.2020.1806777.

[70] Mohoena, N. and Dolan, M. 2020. Climate Change's Disproportionate Impact on Women: Agricultural Workers in South Africa. Georgetown Journal of International Affairs. https://gjia.georgetown.edu/2020/07/19/climate-change-disproportionate-impact-on-southafrican-women/ (accessed on the 6th April 2022)

Box. 2.3 : Electricity sector in Mauritius - towards a universal coverage and clean energy

The Central Electricity Board (CEB), established in 1952 is the main institution responsible for electricity supply in Mauritius. During its first year of operations, shortages in rainfall impacted power supply and hence, the CEB decided to set up a thermal power plant. The government's priority after independence in 1968 was to ensure the consistent supply of electricity. In the same year, a national rural electrification programme was established, eventually completing in 1981 . Schools, Central Water Authority pumping stations, housing estates, stone crushing plants, poultry farms, irrigation stations and construction sites were connected to the power supply network in the 1970s. In the 1980s, the transmission and distribution networks were expanded across the island, to meet the rising demand from the textile, tourism, and construction sector.

The electricity sector has been marked by the participation of the private sector which produces approximately 60 percent of electricity . Agreements between the private sector and the CEB had been in place since 1957, when St. Antoine Sugar Estate sold excess electricity generated from bagasse, the pulp left after juice is extracted from sugar cane to the CEB. Subsequently other sugar factories followed suit by transferring their surpluses to the grid. Médine Sugar Estates was the first sugar factory to export electricity to CEB under a contract in 1979. In 1991, the introduction of the Bagasse Energy Development Programme provided the necessary incentives to sugar factories to improve their operational efficiency and encourage the use of bagasse for energy production. The CEB has power purchase agreements with independent power producers operating dual-fired coal and bagasse plants and producing electricity on a year-round basis depending on actual harvest conditions.

The size of the island was a constraint for a multi-supplier electricity sector. The CEB opted to act as a vertically integrated company remaining under government ownership. Reforms followed in 2003. As the heavy reliant on fossil fuels for electricity generation was a concern, the government decided to promote the use of renewable energy and encourage investment in solar, wind, and waste to energy systems. In 2010, with the support of the United Nations Development Programme, the small-scale distributed generation scheme was launched for households, schools and public institutions to install small-scale photovoltaic (PV) panels and wind turbines by providing a targeted feed-in tariff scheme . The Home Solar project followed in 2017 which installed 10,000 rooftop solar panels on the houses of families in the lowest income group . The new 'CEB Green Energy Scheme for SMEs' is expected to operate under the principle of net-billing discount with around 2000 roof-mounted grid-tie solar PV kits will be integrated into the grid. Research is also being carried out on ocean energy solution.

Evidence suggests that, on average, it takes 25 years to increase access to electricity from 20 percent to 80 percent of the population or 2.4 percentage points per year[79]. Yet, if Africa is to meet the goal of universal energy access by 2030, electricity generation capacity needs to grow at an annual rate of 13 percent[80].

Electricity access levels have enormous implications for enabling economic and human development. Empirical evidence has established causality between energy consumption and economic growth in the Southern Africa region, indicating that energy is a driver to economic growth in the long run[81]. The level of consumption has a direct impact on the financial position of power utilities which require sufficient usage at scale to be financial sustainable. As electricity consumption is low, many power utilities in this region are faced with financial crisis[82] making expansion and investment difficult.

Affordability is a key determinant for investment in power generation. The low consumption of electricity especially in rural areas (table 2.5) is caused by several factors including a low willingness or ability to pay for electricity access, low and irregular income, and poor housing quality. With constrained supply, coupled with the fact that many power generating utilities suffer financial distress, there is a continuous risk of energy insecurity, causing frequent power blackouts in most countries, another cause of the low willingness to pay.

[71] Chidakwa, P., Mabhena, C., Mucherera, B., Chikuni, J., Mudavanhu, C. 2020. Women's Vulnerability to Climate Change: Gender-skewed Implications on Agro-based Livelihoods in Rural Zvishavane, Zimbabwe. Indian Journal of Gender Studies. Volume: 27 issue: 2, page(s): 259-281.

[72] AfDB (2011). The Link Between Climate Change, Gender and Development in Africa. The African Statistical Journal, Vol. 12 (May), pp. 119-140. https://www.afdb.org/fileadmin/uploads/afdb/Documents/Publications/The%20Link%20Between%20Climate%20Change%20Gender%20and%20Development%20in%20Africa%20St12.pdf

[73] 'Access' refers to households with electricity in their homes whether provided by the central grid, mini-grids, or stand-alone off-grid systems.

[74] CEB (2022) https://ceb.mu/company-profile/history

[75] Palanichamy, C., Babu, N. S., Nadarajan, C. 2004. Renewable energy investment opportunities in Mauritius—an investor's perspective. Renewable Energy vol.29, pp.703-716.

[76] Statistics Mauritius (2021). Digest of Energy and Water Statistics 2020.

[77] Hadush, S. Y., Bhagwat, S. R. B. 2019. A Comparative Study of Renewable Energy and Electricity Access Policies and Regulatory Frameworks in the Indian Ocean Islands The Case of Mauritius, Seychelles, Madagascar and Comoros. European University Institute, Badia Fiesolana, I – 50014 San Domenico di Fiesole (FI) Italy. https://www.commissionoceanindien.org/wp-content/uploads/2019/08/FSR_Final.pdf (accessed 19th June 2021)

[78] https://african.business/2018/07/economy/mauritius-how-the-island-nation-is-developing-its-power-sector/

[79] Blimpo, Moussa P., and Malcolm Cosgrove-Davies. 2019. Electricity Access in Sub-Saharan Africa: Uptake, Reliability, and Complementary Factors for Economic Impact. Africa Development Forum series. Washington, DC: World Bank. doi:10.1596/978-1-4648-1361-0. Pp.12.

[80] Gujba, H., Thorne, S., Mulugetta, Y., Rai, K., Sakona, Y. 2012. Financing low carbon energy access in Africa. Energy Policy, vol. 47, pp.71-78.

[81] Fatai, B. O. 2014. Energy consumption and economic growth nexus: Panel co-integration and causality tests for Sub-Saharan Africa. Journal of Energy in Southern Africa, vol. 25, no.4, pp.93-100.

The lack of investment and finance have impeded regional efforts to tap into abundant clean and renewable energy resources (wind and solar) for most countries. Still, the rise in demand, and extending access to more subscribers will require massive investment. With increasing international commitment to promote environmentally-friendly sources by all Southern African countries, renewable energy could be a viable and transformative option.

Sources of electricity generation - current status

Although energy resources vary greatly among the countries, biomass is still the dominant traditional fuel source in the region. Households without electricity tend to rely on biomass such as wood, crop residues and charcoal to meet their energy needs and households are the dominant user of biomass. However this is unsustainable energy and leads to a reduction of both the natural forests and their capacity to absorb carbon. Deforestation, desertification, and soil degradation also have implications on water resources and food production due to erosion, and declining arable lands. Households are also at risk of indoor air pollution and soil degradation.

Electricity generation is classified to five power pools, namely Central African Power Pool, East African Power Pool, North African Power Pool, Southern African Power Pool, and West African Power. Table 2.6 shows the generation capacity for each of the power pools together with the proportion of thermal capacity in each. Southern Africa had the highest capacity of 56.297 GW with 81.05 percent being thermal power plant installation while central African Power Pool had the lowest in terms of installed capacity and the proportion of thermal power plants.

Table 2.6 : Electricity generation capacity in African countries

	Southern Africa TWh/y	East Africa TWh/y	Central Africa TWh/y	West Africa TWh/y	North Africa TWh/y
Generation Capacity	56.297	49.586	4.442	21.744	33.197
% thermal generation	81.05	46.07	34.46	79.35	90.3

Source: Pappis, I. H. (2019). Energy projections for African countries. Westerduinweg 3, 1755 LE, Netherlands: European Commission. doi:10.2760/678700. Okunade et al. (2022).

Table 2.7 shows the different sources of electricity generation in 2019. The total generation stood at 294,311GWh for the 13 Southern African countries of which 79.7 percent was from non-renewable energy. 75 percent of electricity generation is from coal, a source of GHGs, and dominated by South Africa. The main source of renewable energy is hydroelectric power which presents a huge potential in the region.

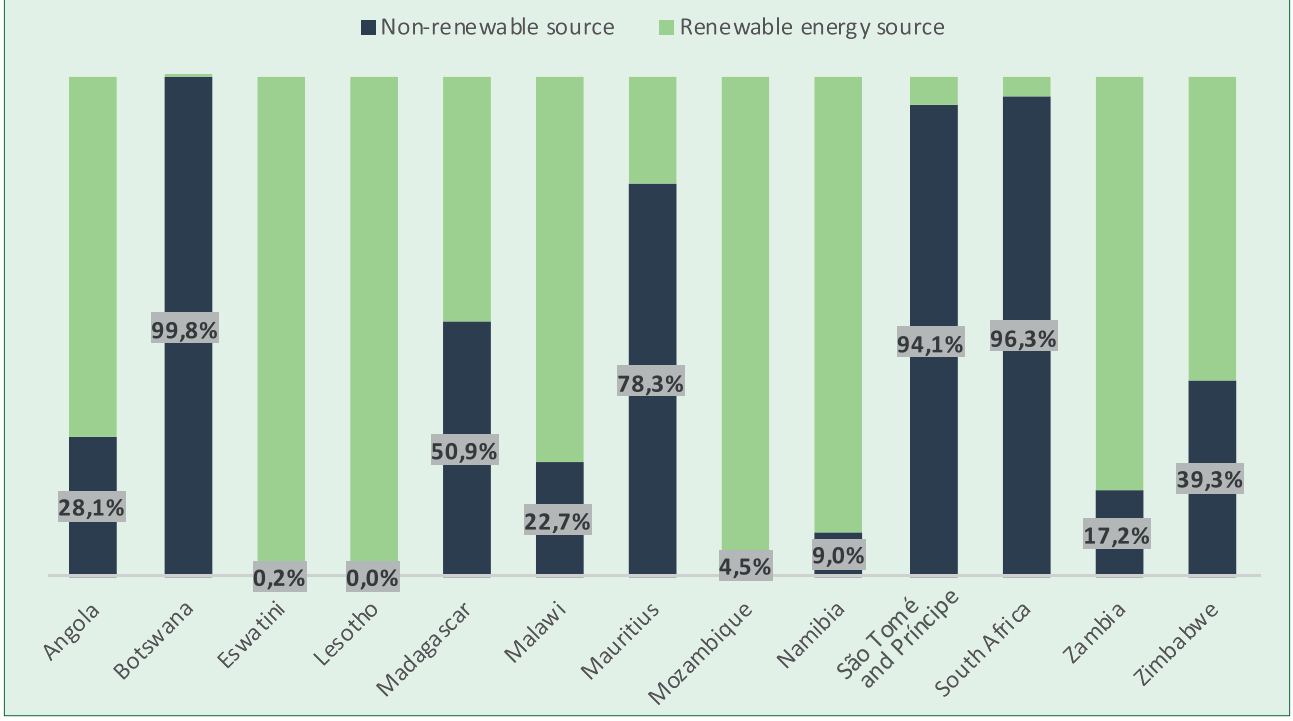
Table 2.7 : Sources of electricity generations in GWh (2019)

Countries	Non-renewable	Renewable						
		Total	Hydro	Solar	Wind	Bioenergy	Geothermal	Total
Angola	4996	12781	12562	18	0	200	0	17777
Bostwana	3326	6	0	6	0	0	0	3332
Eswatini	1	411	225	1	185	0	0	412
Lesotho	0	503	502	0	0	0	0	503
Madagascar	974	939	915	23	0	1	0	1913
Malawi	429	1458	1358	47	0	54	0	1887
Mauritius	2535	702	99	129	15	460	0	3237
Mozambique	711	14982	14826	2	0	65	0	15693
Namibia	164	1654	1288	348	18	0	0	1818
São Tomé & Príncipe	96	6	6	0	0	0	0	102
South Africa	214893	8290	793	6771	294	431	0	223183
Zambia	2586	12427	12335	14	0	78	0	15013
Zimbabwe	3710	5731	5455	19	0	257	0	9441
Total	**234421**	**59890**	**50364**	**7378**	**512**	**1546**	**0**	**294311**

Source: Energy Profile - International Renewable Energy Agency

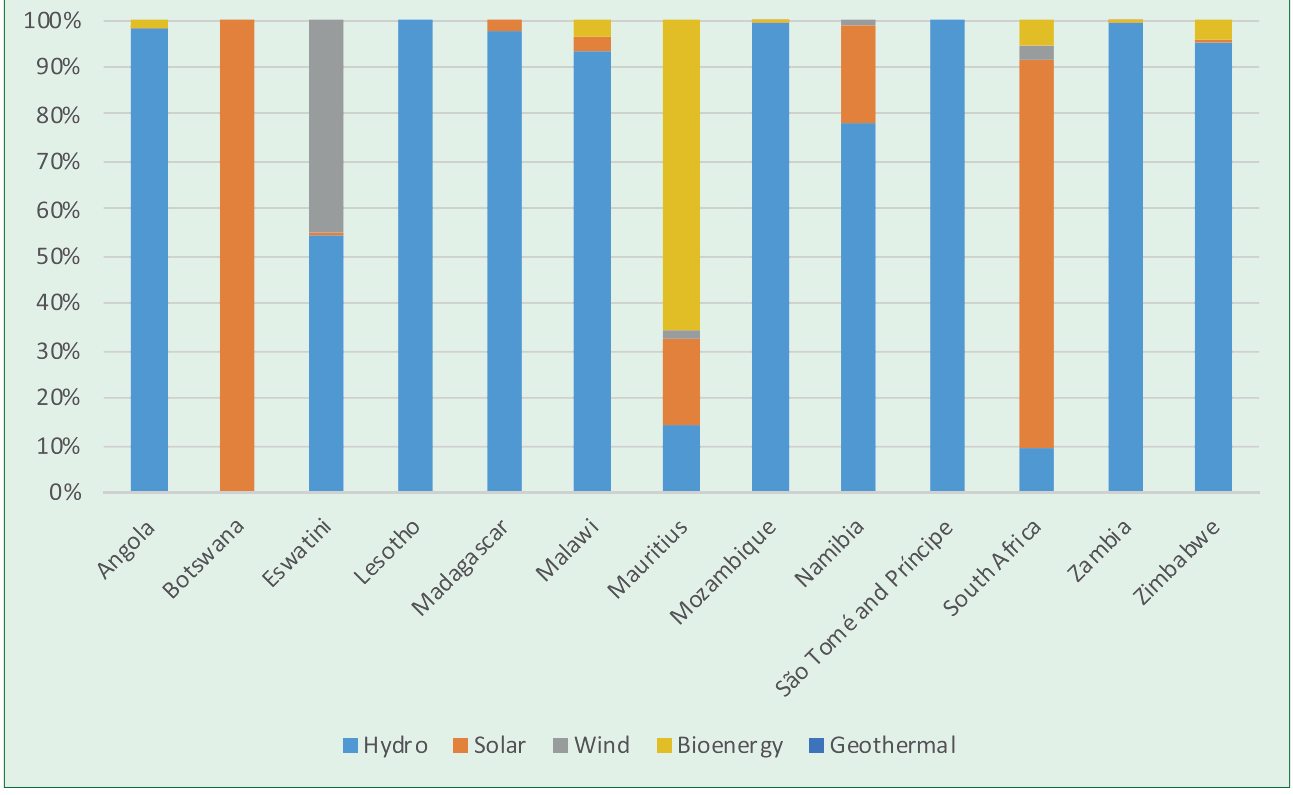
[82] World Bank (2016). Financial Viability of the Electricity Sector in Developing Countries: Recent Trends and Effectiveness of World Bank Interventions. World Bank Group/ https://ieg.worldbankgroup.org/sites/default/files/Data/reports/lp_financial_viability_electricity_sector_0.pdf (retrieved on the 15th March 2022)

Figure 2.3 : Renewable vs. non-renewable energy sources



Source: Energy Profile - International Renewable Energy Agency

Figure 2.4 : Renewable energy sources



Source: Energy Profile - International Renewable Energy Agency

The Southern African region has a relatively rich mix of energy sources: coal, crude oil, biomass, hydropower and solar. Angola is the only country with substantial oil reserves[83], although considerable coal reserves are found in Mozambique, Zimbabwe, Botswana, Eswatini and South Africa. South Africa alone accounts for 90% percent of Africa's proven reserves. Figure 2.4 shows a comparison of the renewable and non-renewable sources for the 13 Southern African countries. Non-renewable energy dominates in five countries, namely Botswana, Madagascar, Mauritius, São Tomé & Príncipe, and South Africa.

Box. 2.4 : Electricity generation in the 13 Southern African countries

- **Angola** currently derives 71.9 percent of its electricity from renewable energy sources, mainly hydro. Solar and bioenergy accounts less than 1.1 percent. The main non-renewable energy source is thermal (28.1 percent) from oil derivatives. Energy consumption in rural areas is primarily based on biomass (firewood and charcoal). Angola has devoted considerable efforts towards investments in new dams and distribution networks over the years. These include the upgrading of the Cambambe dam and the construction of the Capanda and Laúca dam and the Caculo-Cabaça dam. The Gove and Lomaum dams were also rehabilitated. A major issue facing Angola is that tariffs that do not reflect true costs[84].
- **Botswana** is vested with large coal reserves of around 200 billion tons and generates most of its electricity from coal, creating 98.1 percent of electricity from non-renewable sources. The renewable energy source comes from solar of 450MW installed capacity. Additional demand is met through electricity imports, primarily from South Africa. There is a huge potential to develop solar further, with 3,200 hours of sunshine per year, and irradiance of 6640 Wh/m2/day[85]. Electrification in urban areas stands at 88.3 percent and 27.6 percent in rural areas while national electrification is 70.2 percent.
- **Eswatini** imports approximately 80 percent of its energy from South Africa. The majority of rural households use firewood as their main energy source. Given the high rate of deforestation, household consumption of biomass consumption is expected to be limited[86]. Bagasse, a waste product of the sugar industry, is used by the industry for electricity and steam generation. The other renewable energy is hydropower.
- **Lesotho**'s primary energy base consists of hydroelectricity at 98.1 percent with an installed capacity of 76 MW only. The rest of the electricity demand for Lesotho is met through purchased electricity from South Africa, through the Southern African Power Pool. Estimates indicate that Lesotho's large-scale hydropower potential is approximately 450 MW[87]. About 90 percent of rural households in Lesotho use biomass (wood, agricultural residues and cow dung) for thermal energy and cooking[88].
- **Madagascar**'s energy mix has evolved considerably over the last decade. Renewable energy, especially hydropower, which was the main source of energy for electricity generation, has changed over the last 15 years for various reasons. This situation has been reversed; and currently fossil fuels dominate electricity generation (51 percent), while hydropower represents around 47.8 percent of the country's energy source[89].
- **Malawi**'s current electricity generation capacity is only 351MW against an estimated suppressed demand of 400MW. The hydroelectric power plants are mostly located on the Shire River. Biomass accounts for about 90 percent of energy supply. Access to grid electricity is at 11.2 percent in 2019, one of the lowest in the world. Malawi's electricity generation deficit is not only a hindrance to new investments in manufacturing, industry, mining and tourism but also detrimental to the social and economic well-being of its people[90].
- In **Mauritius** 78.3 percent of primary energy requirement in the electricity sector comes from imported fossil fuel. The remaining comes from renewable energy sources such as hydro at 3.1 percent, solar at 4 percent, wind 0.5 percent and bioenergy dominating at 14.2 percent. The energy obtained from solar (photovoltaic systems) had doubled due to the Small-Scale Distributed Generation (SSDG) scheme implemented by the Central Electricity Board, which allows Small Independent Power Producers to feed excess electricity generated by PV plants installed on their premises to CEB grid. Four major constraints to renewable energy are its high initial investment cost (a financial barrier), low grid absorption capacity (a technical barrier), competing land uses (a policy/regulatory barrier), and social acceptability (a social/behavioural barrier)[91].
- **Mozambique** sources 95.5 percent of electricity from hydropower and the remainder from fossil fuel. The power sector in Mozambique faces three key challenges: to provide reliable and efficient electricity supply to the population; manage the increase in the electricity demand; and to extend access to electricity to the vast majority of the population[92].
- **Namibia** imports more than 50 percent of its electricity from neighbouring countries, South Africa, Zambia, and Zimbabwe. It has three electricity power stations: the Ruacana hydroelectric power station, which depends on the in-flow of rainfall from the catchment areas in Angola; the Van Eck coal power station using coal imports from South Africa; and the Paratus diesel plant[93]. The main sources of energy used by households for cooking purposes are wood and charcoal at 54 percent[94].
- **São Tomé & Príncipe**'s imported fuel such as diesel results in a high cost of production in thermal power stations, and a high consumer price, combined with an obsolete network of production and distribution of energy with technical and non-technical losses of 34.5 percent in the electrical system[95].

[83] Musango and Brent, A. C. (2011). Assessing the sustainability of energy technological systems in Southern Africa: A review and way forward. Technology in Society 33 (2011) 145–155.

[84] Republic of Angola (2021b) (NDC) (ibid).

[85] Bostwana (2019) Botswana's Third national Communication (Ibid)

Box. 2.4 : Electricity generation in the 13 Southern African countries

• **South African** energy is highly dependent on the country's cheap and abundantly available coal, which comprises roughly 92 percent of energy generation, supplemented through crude oil imports[96]. Non-renewable energy in the electricity sector represents 96.1 percent. A limited quantity of natural gas is also available for energy production. Enriched uranium is imported for South Africa's nuclear power plant, Koeberg. Hydropower is the primary source of renewable energy for the country, however as of 2017, it comprised just 1 percent of energy generation, followed by biomass and solar.

• Hydropower in **Zambia** is the most developed form of energy in the country and contributes 82.2 percent in 2019 to the total electricity generation, followed by coal at 10 percent. Biomass is the predominant source of energy in Zambia accounting for more than 70 percent of total primary energy supply. The main forms and products of biomass include wood fuel (charcoal and firewood), biogas, pellets, briquettes, biofuels and gel fuel mainly used as a household fuel for cooking and heating[97]. Zambia has had to ration electricity because water levels in the dams have dropped as a result of lack of rain which is attributed to climate change.

• **Zimbabwe** has suffered chronic electricity shortages in recent years. This, coupled with poor electricity coverage in rural areas, has led increasing numbers of Zimbabweans to install small solar systems or petrol- or diesel-powered generators. As the shortages have intensified, more people have turned to firewood for cooking, heating, and agricultural activities such as tobacco curing. A recent study found that 37 percent of urban households are using firewood as a source of energy[98].

Impacts of climate change on current electricity systems

The rise in temperature and changes in the patterns of precipitation are expected to negatively affect hydroelectric installations in four major ways[99]: surface water evaporation, reduced run-off due to drought, increased run-off due to flooding, and siltration deposits. Siltration refers to the deposition of particles of the river load and is the consequence of erosion which is particularly prevalent in some parts of Southern Africa where heavy rains and consequently rivers can be aggressive. Increasing temperature generally increases in evaporation and as temperatures are expected to increase globally it can be expected that evaporation on large open waters would also increase (e.g. the Zambezi River would have a higher potential for evaporation). The greatest loss of potential water resources from hydroelectric facilities comes from the evaporation of water from the surface of reservoirs which would otherwise have been available for downstream use as well as for electricity generation. Box 2.5 provides a brief on the potential impacts of climate change on hydroelectric power. Evaporation losses per annum have been calculated to be on average 1.1 metres of depth per square kilometre of surface area.

The direct impact of drought is that the run-off is reduced and consequently the storage capacity in dams is reduced. In recent years there have been interruptions in some hydropower plants because of severe drought. In Zimbabwe, Kariba contributes 50 percent of the country's electricity needs, but generation dropped significantly by 8 percent due to drought in 1992. The high reliance on hydropower in many Southern African countries pose significant risk to electricity supply.[100]

Unexpected flooding can be detrimental to large dams was large loads of sediments carried by the rivers settle in the dams and lakes. For in-stream hydro plants, large logs and vegetation can also cause damage or block up the system. However, in some cases, the increased volume of water could allow for increased generation potential. Non-existent or sparse vegetation and the desiccation of soils during dry seasons can make the soils particularly vulnerable to the water action.

[86] Third National Communication to the UNFCCC (ibid).
[87] Klunne, W., J. 2013. Small hydropower in Southern Africa – an overview of five countries in the region. Journal of Energy in Southern Africa • Vol 24 No 3, pp. 14-26.
[88] The Kingdom Of Lesotho's First Biennial Update Report 2021.
[89] Troisième Communication Nationale À La Convention Cadre Des Nations Unies Sur Le Changement Climatique, Octobre 2017.
[90] INDC.
[91] INDC Mauritius.
[92] World Bank (2015). Republic of Mozambique Mozambique Energy Sector Policy Note Energy Sector Policy Work Report No: ACS17091https://openknowledge.worldbank.org/bitstream/handle/10986/24441/Mozambique000Energy0sector0policy0note.pdf?sequence=1&isAllowed=y
[93] CRCP, Namibia World Bank.
[94] Third National Communication to the United Nations Framework Convention on Climate Change.
[95] Third National Communication.
[96] CRCP South Africa World Bank.
[97] Third National Communication To The United Nations Framework Convention On Climate Change (Unfccc).
[98] Climate Change in Zimbabwe Facts for Planners and Decision Makers.
[99] Mukheibir, P. Possible climate change impacts on large hydroelectricity schemes in Southern Africa. Journal of Energy in Southern Africa 18(1): 4–9.
[100] IPCC (2022), pp.9-22.

Box 2.5. Potential impacts of climate change on hydroelectric power

Change in rainfall patterns	a) Changing annual or seasonal patterns can impact river flows and water levels, affecting production. Not only a reduction in flow can be negative; an increase can also affect operational conditions depending on the capacity of the plant. b) Changes in precipitation and temperature may affect the moisture levels of soil, which provides storage and regulates run-off. c) Siltation caused by erosion can affect the soil and reduce power output.
Flooding and intense rain	a) Flooding can damage infrastructure and increase the need for spilling water b) Flooding may pose a significant risk to dam safety. c) Flooding can also transport debris and damage dams and turbines
Air temperature	a) Higher air temperature will increase surface evaporation, reducing water storage and power output. b) An increase in temperature might increase operational costs and affect the efficiency of the equipment, causing mechanical stress.
Others	a) El Nino ~ the Southern Oscillation influences precipitation. Southern Africa could be impacted as well. b) The performance of gates can be affected by an increase in sediment content in the water and suspended materials c) Landslides increase the level of sediment in water, which can cause other problems, especially in areas with high agricultural activity. d) Increased intensity and frequency of storms and extreme weather events may affect the plants. e) Conflicts with other uses (especially irrigation) can affect the availability of water.

Source: Compiled by Solaun, k. & and Cerda, E. 2019. Climate change impacts on renewable energy generation. A review of quantitative projections. Renewable and Sustainable Energy Reviews, vol.116, 109415. (adapted to south African countries.)

Prospects for renewable energy

The geographical position of these thirteen countries provides a major advantage in tapping renewable sources of energy[101]. There is a significant potential for hydropower, biomass resources (woody biomass)[102], PV technic with solar insolation[103], wind energy depending on location[104], and geothermal energy potential[105]. More than 90 percent of Africa's economically viable hydropower potential, equivalent to about one-tenth of the world's total, is unexploited[106]. The overall hydropower potential for the Southern Africa region is estimated at approximately 1080 terawatt hours per year (TWh/year) where the current utilised capacity is less than 31 TWh/year[107]. The untapped hydropower generation potential in regional states such as Angola, Mozambique and Zambia (countries with reliable water resources) have the capacity to supply the whole region with electricity.

Solar potential is distributed fairly uniformly and more than 80 percent of African land receives more than 2 MWh/year per m2. The continent also has a substantial energy potential from wind, particularly in the coastal regions, such as Northern Africa, Eastern Africa, and Southern Africa – since these regions have generally better wind resources. Moreover, a seasonal analysis of wind was conducted by Fant et al. (2016)[108] to assess the probable changes in renewable resources due to climate change by 2050 and concluded for the most Southern African region, changes in solar and wind potential by 2050 are expected to be small. The most extreme wind speed changes may occur over the ocean. Solar and wind can be produced at competitive prices and can bring power to rural areas without the need for expensive grid infrastructure[109] . Despite this huge potential, they account for just 3 percent of current capacity.

[101] Mumgai et al. (2022).
[102] Estimated at over 70 billion tonnes.
[103] With an estimation at 1800–2850 kWh/m2.a, the potential for the African continent is estimated at 33– 8,700 TWh/a while concentrating solar power potential is estimated at 7–40,500 TWh/a (Gujba et al. 2012).
[104] Estimates of wind speeds at 6–7 m/s in Southern Africa.
[105] Estimated at about 14,000MW.
[106] Blimpo, Moussa P., and Malcolm Cosgrove-Davies. 2019. Electricity Access in Sub-Saharan Africa: Uptake, Reliability, and Complementary Factors for Economic Impact. Africa Development Forum series. Washington, DC: World Bank. doi:10.1596/978-1-4648-1361-0. License: Creative Commons Attribution CC BY 3.0 IGOP.p.33.
[107] Mpandeli et al. (2018).
[108] Fant, C., Schlosser, C. A., and Strzepek, K. 2016. The impact of climate change on wind and solar resources in southern Africa. Applied Energy, vol.161, pp.556-564
[109] Renewable Energy Transition Africa, 2021

Biomass represents an opportunity by providing renewable energy for heavy manufacturing, as it can be used to produce process heat. Geothermal energy is a resource of considerable importance in the Rift Valley in Eastern Africa, stretching from Mozambique to Djibouti, with a total potential of approximately 15 GW of installed capacity. Geothermal heat can also be used for low temperature heat, required by the manufacturing industry, making it a suitable substitute for fossil fuels.

Table 2.8 : Estimated theoretical onshore renewable energy potential in Africa

	Southern Africa TWh/y	East Africa TWh/y	Central Africa TWh/y	West Africa TWh/y	North Africa TWh/y
Solar PV	246212	308105	154916	240611	499898
Wind power	171739	242096	74936	140513	348782
Biomass power	96	642	1572	64	0
Hydropower	415	334	570	101	56
Geothermal	0	105	0	0	0
Total	418462	551282	231994	381289	848736

2.2. Improving climate resilience and accelerating energy transition in Southern Africa

The vulnerability of Southern Africa countries to climate change requires adaptation strategies to be implemented to build resilience. At the same time, there is a firm commitment to reduce emissions under the Paris Agreement of the Conference of Parties, unlike the Kyoto Protocol[110]. A low carbon development pathway combining low carbon energy and climate resilience adaptation becomes imperative for Southern African countries. When mainstreamed in development plans, the climate resilience and low carbon development pathway has a potential to promote economic transformation, shift resources to high productivity sectors, generate wealth and reduce poverty. A major challenge is to develop such a synergy.

When the Paris Agreement came into force in November 2016, member countries were invited to submit their proposed post-2020 climate action plans known as Intended Nationally Determined Contribution (INDCs). As countries joined the Paris Agreement, and submitted the Nationally Determined Contributions (NDCs), the document represents their official climate plans. The NDCs form the basis for implementing mitigation action. While the adaptation component of the NDCs was voluntary, most of the countries included adaptation measures and projects. These documents provide the basis for a deliberate energy transition and set out the key measures and strategies developed by the thirteen Southern African countries to build resilience against climate change. Progress towards the NDCs shows that there are strong synergies between mitigation and adaptation strategies and hence, it is increasingly recognised that they cannot be implemented in isolation. So far however, such synergy has not been in evidence.

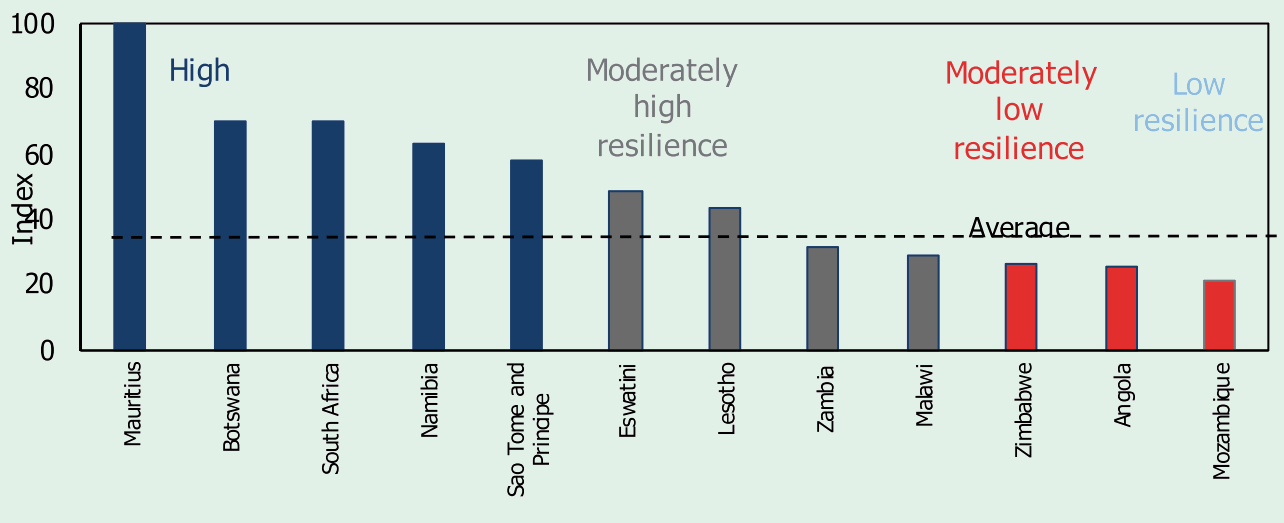
2.2.1. State of climate resilience and readiness in Southern Africa

While Africa is the second most climate vulnerable region of the world and shows the least climate readiness, Southern African countries are the least vulnerable with relatively high readiness. They are also reasonably well positioned to implement their climate policies. Figure 2.5 shows that four have moderate high resilience to moderate low level of resilience and therefore require strengthened standards and capacity to cope with or recover from the negative effects of climate change. Zimbabwe, Angola, and Mozambique are at the lowest end of climate resilience. The drivers of their low resilience could include their exposure to recent droughts and high poverty levels created as a result. For instance, the El Niño conditions during the 2015/16 planting season caused Southern Africa's worst drought in 35 years, which created severe food and water shortages and compounded existing vulnerabilities in all sectors. Using multi-dimensional poverty indices, combined with an assessment of response capacities and exposure, the Regional Interagency Standing Committee Response Plan identified Malawi, Mozambique, and Zimbabwe as Tier 1 countries, with most urgent need for humanitarian assistance[111]. Angola, Lesotho, Madagascar, and Eswatini were classified as Tier 2, while Zambia were placed on a 'close monitoring watch list' and Botswana and South Africa were 'affected by drought but with sufficient coping capacity'.

[110] The Kyoto Protocol was adopted on 11 December 1997 but was enforced on 16 February, 2005. A total of 192 Parties entered into the first legally binding agreement, which was aimed to tackle the adverse impacts of climate change. By adopting individual national policies and measures, each country had agreed to limit or reduce greenhouse gas (GHG) emissions. Under the principle of "common but differentiated responsibility and respective capabilities," the developed countries had pledged to reduce their annual GHG emissions up to an average of 5 percent emission reduction compared to 1990 levels.

Response capacity in numerous Southern African states remains low. Where state capacity is high in the region such as in South Africa, implementation delays and coordination challenges have still hampered effective responses[112]. Without an effective and coordinated response, the region risks a growing humanitarian burden, protracted relief operations, intensified vulnerabilities and a potential rise in migration as income and labour opportunities shrink. In the remaining countries, there have been successes in regional and national responses to both droughts and longer-term climate challenges.

Figure 2.5 : Climate resilience score for Southern African, average 2010-2019



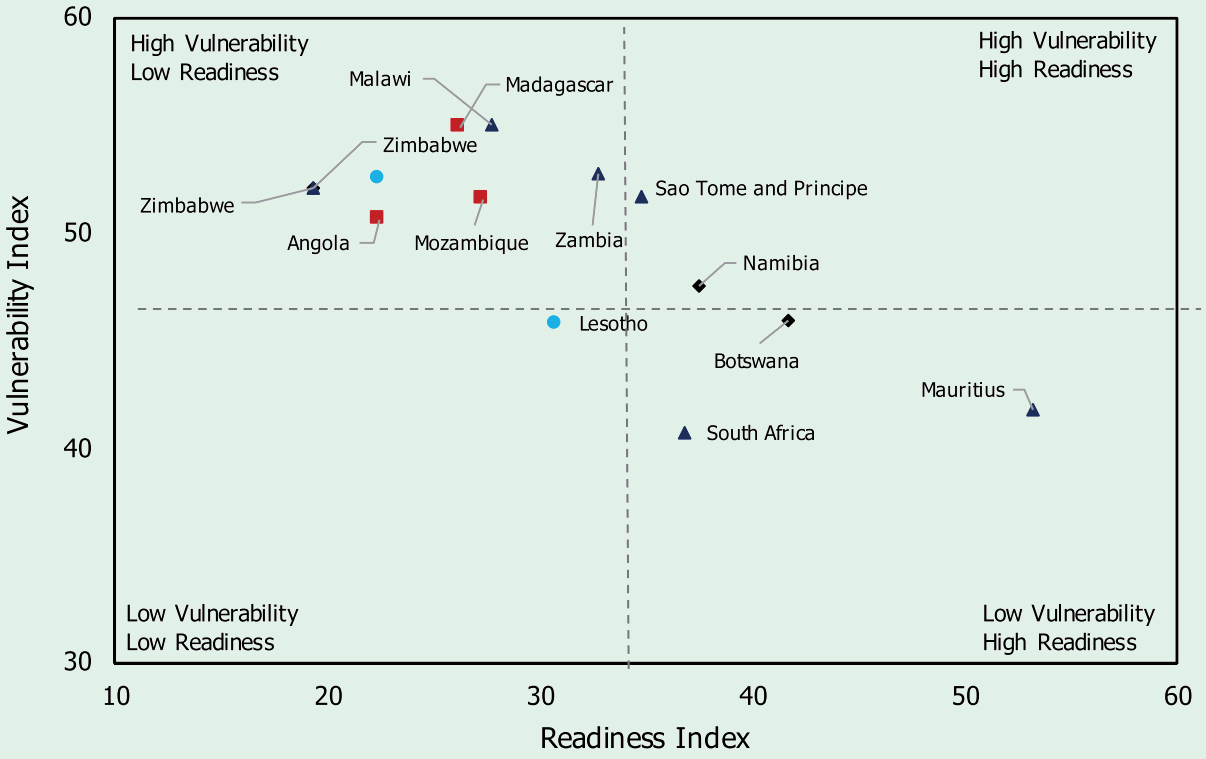
Source: AfDB staff computations

Figure 2.6 shows that most of the Southern African countries are highly climate vulnerable and have a low readiness score. São Tomé and Príncipe and Namibia are the only countries in the region which fall in the quadrant of high vulnerability and high readiness to climate change. Botswana, Mauritius, and South Africa have low vulnerability and high climate change readiness. Effort should therefore be placed on increasing the countries' climate change readiness and lower their levels of vulnerability.

[111] RIASCO (Regional Inter-Agency Standing Committee), 'RIASCO Action Plan for Southern Africa, May 2016 – April 2017', July 2016. https://reliefweb.int/report/world/report-riasco-action-plan-el-ni-o-induced-drought-southern-africa-20162017 (accessed on 12 July 2017).

[112] Benkenstein, A. 2017. Climate Change Adaptation Readiness: Lessons From the 2015/16 El Niño For Climate Readiness In Southern Africa. South African Institute of International Affairs. Occasional Paper 250. https://www.africaportal.org/publications/climate-change-adaptation-readiness-lessons-from-the-20152016-el-ni%C3%B1o-for-climate-readiness-in-southern-africa/ (accessed on 18th August 2022).

Figure 2.6 : Classification of countries by climate vulnerability and readiness characteristics, average 2010-2019



Source: AfDB staff computations

2.2.2. Building climate resilience

There are commonalities in adaptation strategies among the thirteen countries, especially over important areas of intervention: agriculture, water, health, biodiversity, and disaster risk management. Countries with coastlines suffer from sea level rise and have adaptation measures in the coastal regions. These sectors make up three-quarters of quantified adaptation finance needs according to the Adaptation Gap Report 2021[113]. The NDCs for the thirteen Southern African countries, together with their National Communication reports to the UNFCCC, were reviewed to highlight their adaptation needs and mitigation priorities, and to identify potential synergies.

Building a climate resilient agriculture sector

Major adaptation strategies in the agricultural sectors include autonomous adaptation (shifts in agricultural practices), embracing new technologies and transformational changes, and improving behavioural change through trade policies and shifts in diet[114]. Four common themes from the National Communication to the UNFCCC 2015 Paris Agreement and NDCs related to the agriculture sector are the implementation of early warning systems, water management, crop management and infrastructure development. The major adaptation is crop management and one main proposal from almost all countries is the application of climate smart agriculture (CSA) and conservation agriculture, which have great GHG mitigation benefits (Box 2.6).

Ensuring water availability and accessibility

Enhancing water availability and accessibility remain at the centre of adaptation strategies for all thirteen southern African countries. Expanding rainwater harvesting and water storage, implementing conservation techniques and introducing water demand management are common adaptation strategies for most countries. Reforms in the water sector are prioritised in the adaptation strategies for Botswana and Madagascar where the development and implementation of water pricing structures are highlighted to encourage more efficient water use. Mozambique and São Tomé & Príncipe also seek to establish a regulatory framework for dam and water-way security. Lesotho calls for a decentralisation of urban centres to reduce pressure on water. Water recycling and reuse are also part of the strategies in Botswana and Lesotho while Mozambique and Namibia pointed to desalination or plan to develop water management. Madagascar is proposing the implementation integrated catchment conservation and management programmes, and water-saving infrastructure for different types of water use.

[113] United Nations Environment Programme (2021). Adaptation Gap Report 2021: The gathering storm – Adapting to climate change in a post-pandemic world. Nairobi.

[114] Nhamo et al. (2019).

Box. 2.6 : Climate smart agriculture and conservation agriculture

Climate smart agriculture (CSA) describes a suite of interventions that aim to sustainably increase productivity whilst helping farmers to adapt their farming systems to the predicted effects of climate change and to manage climate risk more effectively . It is a cleaner production approach which sustainably increases crop productivity and is designed to enhance the resilience of smallholder farming systems in Africa. One of the principles of CSA is conservation agriculture, i.e. minimum soil disturbance, crop residue management, and crop rotation, particularly using legumes. Farmers may implement minimum soil disturbance either through planting basins or ripping; they do not plough or make planting ridges as conventional farming does. Crop residues that remain on the soil surface protect it from the physical impact of rain and wind and enhance soil ecology. Crop rotations interrupt the infection chain between subsequent crops and make full use of the physical and chemical interactions among plant species; they increase soil moisture, macro-fauna and carbon content.

CSA may lead to various improvements at farm and landscape scale: soil fertility, crop yields and food production, water storage and agriculture ecosystems resilience; resource-use efficiency, residue valorisation and recycling; and mitigation in the form of reduced greenhouse gas (GHG) emissions and enhanced carbon storage in soils and biomass[116].

Branco et al. (2021)[117] analysed the impact of CSA in Malawi and Zambia. The two countries had witnessed a decrease in crop productivity, due to land and soil degradation and poor farming methods, which were exacerbated by climate change. This fall in productivity led to unfavourable economic and environmental conditions for most rural households which depend upon agriculture for their livelihoods. They concluded that GHG mitigation benefits from the CSA practices ranged between 0.1 and 1.6 tCO^2e per hectare. Agroforestry leads to more sizeable annual mitigation benefit, while more isolated application of cover crops, as well as the combined application of reduced tillage and residue retention, or reduced tillage and legume inclusion can generate bigger mitigation benefits up to 0.8 tCO2e per hectare. The combined application of either reduced tillage and cover crops, no-till and residue retention, no-till and legume inclusion or no-till and cover crops, leads to higher GHG mitigation benefits, up to 1.6 tCO^2e per hectare.

Moreover, the implementation of CSA is also economically viable. This is the finding emanating from the study of Mutenje et al. (2019) on the cost-benefit analysis in Malawi, Mozambique and Zambia. The results show that the efficacy of CSA options was context-specific and conditioned by microclimate, labour and the CSA technology combination applied. At the household level, all CSA options analysed were economically beneficial to smallholders.

Protecting health from climate change

Adaptation frameworks for the thirteen countries include a health adaptation strategy to climate change. The establishment of health surveillance and monitoring systems is the common strategy proposed. This is coupled with the need to capture spatial and temporal health data (e.g. in South Africa). In some adaptation frameworks, a need is expressed to raise awareness and understanding of the health implications of a changing climate on health (e.g. Lesotho, Namibia) and to enhance coordination between health departments and other institutions which are connected to climate change (e.g. Madagascar). Understanding health impacts remains an area which has received limited attention.

Namibia establishes a strong link between health impacts and nutrition, while Malawi concentrates on improving agriculture to avoid the deterioration of health of vulnerable groups. Malawi seeks to improve nutrition for infants and the most vulnerable, including crop diversification to improve protection against diseases such as malaria. Namibia seeks to reduce cholera and control malaria risks through increased distribution of insecticide-treated bed-nets and reduce diarrhoea disease through improved water treatment infrastructure.

Conserving and restoring biodiversity and natural resources

Adaptation strategies are also proposed to protect forest resources, biodiversity and wildlife. Botswana seeks to improve the design and enforcement of corridors to connect protected areas, promote conservation, reforestation and afforestation. Namibia is promoting wildlife land use systems to achieve better value for land than could be achieved by other sectors such as agriculture. The provision and management of data is very weak in most countries. Namibia intends to improve the national conservancy information system to include information and indicators on biodiversity and nature, which are useful for effective monitoring of climate change adaptation strategies in the tourism sector. Improvement in the legislative frameworks is emphasized by Zimbabwe, especially to regulate changes in land-use especially to avoid the conversion of forests and woodlands to other land uses.

[115] Campbell, B.M., Vermeulen, S.J., Aggarwal, P.K., Corner-Dolloff, C., Girvetz, E., Loboguerrero, A.M., Ramirez-Villegas, J., Rosenstock, T., Sebastian, L., Thornton, P.K., Wollenberg, E., 2016. Reducing risks to food security from climate change. Glob. Food Sec. 11, 34–43. https://doi.org/10.1016/j.gfs.2016.06.002.

[116] Mutenje, M. J., Farnworth, C. R., Stirling, C., Thierfelder, C., Mupanga, W., Nyagumbo, I. 2019. A cost-benefit analysis of climate-smart agriculture options in Southern Africa: Balancing gender and technology. Ecological Economics, vol. 163, pp.129-137.

[117] Branco, G., Arslan, A., Paolantonio, A., Grewer, U., Cattaneo, A., Cavatassi, R., Lipper, L., Hillier, J., Vetter, S. 2021. Assessing the economic and mitigation benefits of climate-smart agriculture and its iimplications for political economy: A case study in Southern Africa. Journal of Cleaner Production 285 (2021) 12516.

Managing coastal resources

Adaptation activities in the coastal sector are priority areas for islands states such as Madagascar, Mauritius, and São Tomé & Príncipe and for those countries bordering the sea whose population reside in the coastal areas. Madagascar seeks to create a marine reserve system based on increasing resistance and resilience to climate change. Madagascar and Mozambique both aim to promote integrated coastal zone management taking into consideration coastal marine ecosystems such as mangroves and corals, and planning reforestation in previously logged mangrove zones. Sea level rise is major concern for São Tomé & Príncipe and it aims to formulate contingency plans for areas susceptible to flooding by sea level rise and river flow, including developing crisis plans for populated areas (monitoring, warning, and communication) to reduce damage. Coastal management falls within the development of the blue economy, another untapped potential which will help building resilience and energy transition. This subject is further developed in sub-section 2.2.2.

Reducing disaster risk from climate change

Climate smart disaster risk management is considered an initial step to adapting to climate change and variability, providing policymakers with practical measures to allocate resources to reduce current and future risks at all levels[118]. Its three pillars are: addressing changing disaster risks and uncertainties; enhancing adaptive capacity; tackling poverty, vulnerability and their structural causes[119]. The first pillar emphasises the importance of taking a multi-stakeholder approach as well as gathering information from detailed risk assessments and providing access to information through a myriad of forms such as education, early warning, and the media. The second pillar stresses the need to ensure community participation, promoting diversity and learning. The third pillar empowers communities and local authorities, NGOs, international and private sector organisations to support and influence the decisions of national governments. It further emphasises accountability and transparency while aiming at promoting environmentally sensitive and climate smart development.

2.2.3. Moving towards low carbon development pathways accelerating the energy transition

Access to energy is critical to accelerate structural change. The energy systems in the Southern African region face enormous challenges, given the current lack of energy infrastructure. The low level of energy access has serious implications for development prospects in many countries. There is a clear need for an energy transition that will massively expand access to modern energy services. The choice of future energy systems also matters, given the constraints on increasing CO_2 emissions. It is therefore crucial that energy access expansion should be geared towards a low carbon solution and focuses on the advantages of the Southern African countries: their relatively untapped renewable energy potential. These renewable energy resources provide significant opportunities to expand energy infrastructure in the rural areas.

GHG emissions in Southern Africa

The reduction of GHG emissions is a key climate change strategy. The 2015 Paris Agreement encouraged developing countries to continue enhancing their mitigation efforts and to move over time towards economy-wide emission reductions or limitation targets depending on their different national circumstances. The African continent contributes 5.1 percent of global GHGs emission[120] and the 13 Southern African countries emitted 1.7 percent of the global total in 2018 (table 2.10). Of this, Angola and South Africa are the largest emitters in the region, accounting for 10.1 percent and 64.7 percent, respectively, in 2018.

Table 2.9 : Percentage of GHG emissions (thousands tonnes of CO_2 equivalent) 1990-2018 (%)

Country	1990	2000	2010	2018
Southern Africa	1.9	1.8	2.3	1.7
Sub-Saharan Africa	11.6	4.1	4.6	5.1
OECD members	48.2	48.3	48.5	32.4
High Income	47.8	47.4	47.6	32.5
Low Income	7.9	2.2	2.3	2.4
US	20.0	20.0	20.9	13.1
China	6.9	10.8	14.0	26.9

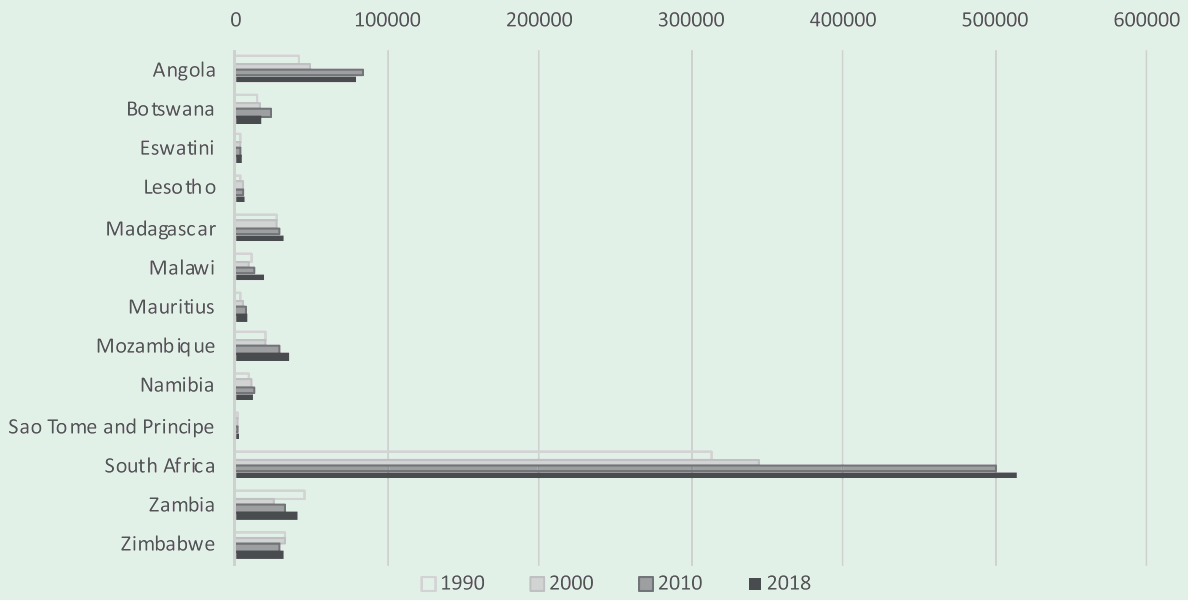
Source: World Development Indicators

[118] Davis-Reddy, C.L. and Vincent, K. 2017: Climate Risk and Vulnerability: A Handbook for Southern Africa (2nd Ed), CSIR, Pretoria, South Africa.

[119] Mitchell, T., Van Aalst, M. & Silva Villanueva, P. 2010, "Assessing progress on integrating disaster risk reduction and climate change adaptation in development processes", Institute of Development Studies, University of Sussex. http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.1015.4399&rep=rep1&type=pdf (Retrieved 20/02/2022).

[120] Data in this section comes from the World Bank Indicators. Total GHG emission is in thousand tonnes of CO_2 equivalent and are composed of CO_2 totals, excluding short-cycle biomass burning (such as agricultural waste burning and savanna burning) but including other biomass burning (such as forest fires, post-burn decay, peat fires and decay of drained peatlands), all anthropogenic CH4 sources, N2O sources and F-gases (HFCs, PFCs and SF6). [https://databank.worldbank.org/source/world-development-indicators#] (Retrieved on 18/03/22).

Figure 2.7 : Total Southern Africa GHGs[121] (thousands tones of CO2 equivalent) 1990-2018



Source: World Bank Indicators

The trajectory African countries are following could see emissions continue to increase. Most countries will continue to rely on fossil fuels because of the slow uptake of renewable energy sources such as solar and wind. [122]Table 2.11 shows the percentage change over the period 1990-2018. The significant increase in CO_2 emissions over the period is a matter of concern, especially for Angola, Lesotho, Mauritius, Mozambique, São Tomé & Príncipe and South Africa. While their combined contribution is insignificant compared to the global CO_2 emissions, it implies that the consumption and production systems are fossil fuel intensive. Rising population and economic growth remain major drivers. Population rates in several Southern African countries such as Angola and Mozambique are the highest in the world. Oil production for Angola explains the substantial increase as improving standards are a driver of GHGs. The link between GDP and GHGs is confirmed by Zimbabwe which has recorded a fall in both GDP and a GHGs over some years.

[121] Total greenhouse gas emissions in kt of CO_2 equivalent are composed of CO_2 totals excluding short-cycle biomass burning (such as agricultural waste burning and savanna burning) but including other biomass burning (such as forest fires, post-burn decay, peat fires and decay of drained peatlands), all anthropogenic CH4 sources, N2O sources and F-gases (HFCs, PFCs and SF6).

[122] Ayompe, L. M., Davis, S. J., and Egoh, B. N. 2020. Trends and drivers of African fossil fuel CO_2 emissions 1990–2017. Environmental Research Letters. Vol.15, No. 124039., pp. 1-10.

Table 2.10 : Percentage change over time GHGs (CO_2 equivalent)				
Country	**1990-2000**	**2000-2010**	**2010-2018**	**1990-2018**
Angola	17.6	69.6	-5.2	89.0
Bostwana	9.2	50.3	-28.1	18.0
Eswatini	11.5	-3.0	6.8	15.6
Lesotho	23.3	20.1	19.4	76.7
Madagascar	4.9	6.0	4.7	16.4
Malawi	-19.8	33.2	57.0	67.8
Mauritius	88.6	34.4	16.6	195.6
Mozambique	-1.3	43.7	24.1	76.0
Namibia	15.5	19.5	-7.7	27.5
São Tomé & Príncipe	11.1	50.0	26.7	111.1
South Africa	10.0	45.2	2.7	64.2
Zambia	-43.4	25.4	26.3	-10.3
Zimbabwe	-2.4	-11.7	11.8	-3.7
Total	4.4	40.0	4.0	52.1
Sub-saharan Africa	-60.7	21.5	57.1	-24.9
OECD members	10.6	10.1	-6.5	13.9
High income	9.4	10.3	-4.6	15.2
Low income	-69.1	12.1	48.7	-48.5
World	10.3	9.8	39.9	69.5

Source: World Bank Indicators

The need for a tandem energy transition and low carbon development

Southern African countries have two main challenges in regard to the energy sector. The first is to ensure universal access to affordable, reliable, sustainable and modern energy services by 2030, as set out in the United Nations' sustainable development goal 7, and the second is to harness the power of renewable energy, not just to prevent the rise in GHGs but also to prevent a carbon lock-in – a situation where fossil fuel-intensive systems perpetuate, delay or prevent the transition to low-carbon alternatives and becomes a future expensive problem.

This Outlook has already argued that energy consumption is important for economic development[123] and it contributes directly to the well-being of the population through its productive uses. Efforts to create jobs and wealth and alleviate poverty depends fundamentally on the availability of primary energy consumption[124]. The low access to electricity is a major cause of concern for Southern Africa countries and where it is lacking, households have recourse to biomass which impacts on forest degradation and their ability to absorb GHGs. It is also observed that a sufficient and reliable electricity supply also means freeing up time for other economic activities which is particularly important for women as water scarcity disproportionately affects them. Electricity access also enables innovation and value creation especially in traditional industries to better integrate and participate in local and global markets and it opens opportunities for digital infrastructure and telecommunications to overcome the inequalities that come with remoteness and lack of access to information.

[123] Fatai (2014) finds that energy consumption in Southern Africa sub-region (Angola, Botswana, Mozambique and South Africa) causes economic growth, and suggests that energy consumption plays an important role in economic growth. It implies that economic growth is dependent on energy consumption, and a decrease (an increase) in energy consumption may restrain (boost) economic growth [Fatai, B. O. 2014. Energy consumption and economic growth nexus: Panel co-integration and causality tests for Sub-Saharan Africa. Journal of Energy in Southern Africa • Vol 25 No 4, pp.93-101].

[124] Mumgai et al. 2022.

Benefits of renewable energy for Southern Africa

Avoiding a lock-in of fossil fuel development

There are many benefits of increasing renewable energy in the Southern Africa region, even if the total contribution of electricity generation to climate change is actually modest compared to any other region in the world. Since the electricity sector is responsible for the largest share of energy-related CO_2 emissions in this region, it is crucial to prevent the majority of countries planning to extend their energy coverage for their population from being locked into fossil fuel energy. Investing in fossil fuel generation capacity, such as coal power plants and natural gas infrastructure has an economic lifetime beyond 2050, which can therefore become a stranded asset. Even if shifting from coal to gas may reduce greenhouse gas emissions in the near-term, investment in natural gas would commit individual countries to long-term fossil fuel infrastructure that would have to be paid back over an extended period. To pursue a low-carbon development path now, these investments will have to be rechanneled towards renewable electricity sources, and at the same time, new energy systems based on efficiency, renewables, and flexible and decentralised (including off-grid) infrastructure must be created to decouple economic growth from fossil fuel sources[125]. This decarbonisation lies at the very heart of the Paris Agreement. While mitigation options in the transport sector relate to savings in fossil fuel and economies of scale, the shift towards electric vehicles is gaining momentum. Vehicles powered by electricity generated would benefit the development of renewable energy sources.

Energy security

The adoption of cleaner renewable sources of energy would result in energy security, providing uninterrupted availability of energy sources at an affordable price, especially in a region which also reduces or prevents upward pressure on prices. Hydropower is climate sensitive and any negative changes in rainfall regimes significantly impact energy availability. In this respect, Southern Africa can take advantage of its abundant clean sources of energy such as solar and wind. Harnessing the abundant solar and wind energy in the region would not only result in energy security but also provide huge water savings.

Employment creation – growing green jobs

The benefits of reducing dependence on increasingly expensive fossil fuels in addition to reducing GHG emissions, include the transition towards a green economy, with opportunities for developing green jobs, poverty reduction and contributing towards the development of a low carbon economy. Box 2.7 shows the findings of the study conducted by the International Labour Organization on the employment prospects of conservation agriculture in Zimbabwe[126].

Box 2.7 : Employment creation in conservation agriculture - Zimbabwe

The agricultural conservation scenario offers great promise as a climate policy that does not directly address the energy sector. Agriculture is Zimbabwe's largest sector and employer. A policy that encourages a shift to climate-smart and conservation farming entails several significant labour market effects. It requires increased organic fertilizer use and production, which creates jobs in supplying industries) and reduced use of chemical fertilizer, which reduces imports, and calls for some 10 percent additional direct agriculture related jobs in soil preparation, management, harvesting and post-harvest activities. The policy's net effect is estimated at close to 100,000 additional full-time equivalent jobs in 2035. And because the investment requirements are very small - and relate more to training and upskilling for farmers than actual capital - the job multiplier is the highest of all the scenarios. A $1 million investment in conservation and climate-smart agriculture is expected to create some 30,000 jobs in 2035.

Source: ILO/UNEP (2021) Measuring the Socioeconomic Impacts of Climate Policies to Guide NDC Enhancement and a Just Transition Zimbabwe Green Jobs Assessment Reports.

The use of renewable sources of energy (wind and solar) is a better option capable of sustainably supplying enough energy for the region, offering the additional advantages of employment creation and proximity to point-of-use. The shift to domestically-produced energy also improves potential employment in the sector, both for activities related to setting up the energy system and for its operation and maintenance. Box 2.8 describes how employment creation results from a renewable energy sector.

[125] Federal Ministry for Economic Cooperation and development (2021) The Renewable Energy Transition in Energy Powering Access, resilience and Prosperity. KFW/GIZ/IRENA.

[126] The Green Jobs Assessment Institutions Network (GAIN) developed by the ILO is a network of policy research institutions and experts that analyses social and employment-related outcomes of greening policies. It assists ILO constituents into undertaking green jobs assessments based on nationally build macroeconomic models. It offers an effective tool and evidence base in guiding employment creation from climate adaptation and mitigation plans. https://www.ilo.org/global/topics/green-jobs/areas-of-work/gain/WCMS_565193/lang--en/index.htm

Box 2.8 : Green jobs in the Zimbabwean renewable energy sector

The International Labour Office (ILO) conducted a study to assess the employment impacts as well as the social and economic effects of Zimbabwe's climate policies as part of its ILO green jobs programme[127] . Energy policies dominate the country's climate policies and consequently, most investments are planned for new generation capacity in renewable energy, especially, hydro power and solar. The assessment concludes that policies to increase electricity generation from the Batoka hydro plant have the greatest potential to create jobs. By 2035, it is estimated that around 300,000 net additional jobs will be added to the economy annually, on average, compared to a baseline scenario. The commercial solar and biogas policy is expected to create approximately 10,000 jobs in each area. The biodiesel, solar water heater and off-grid solar policy is projected to create approximately 5,000. Total employment effects are based on capital investments. In relation to the employment multiplier, in the case of biogas, USD $1 million invested will stimulate the creation of around 130 jobs economy-wide in 2035 while the figure stands at 25 jobs for commercial solar and some 100 jobs for the Batoka hydro dam. Comparing the total impact of the commercial solar policy to the biogas policy, around 10,000 additional jobs in 2035 will be created and total investments in biogas are only one-quarter of those in commercial solar.

Source: ILO/UNEP (2021) Measuring the Socioeconomic Impacts of Climate Policies to Guide NDC Enhancement and a Just Transition Zimbabwe Green Jobs Assessment Reports,p5.

Decreasing health risks

Renewables will also help to reduce health-related risks[128] and premature mortality from air pollution. Indoor air quality is an important issue in Africa both in rural areas and cities and the use of clean energy will benefit several countries.

The low carbon pathway through the lens of NDCs

The low carbon development pathway is already the focus of Southern African countries, through the submission of their NDCs, stating their official climate projects and plans. Hydroelectric power plants (Angola, Eswatini, Madagascar, Malawi, São Tomé & Príncipe), solar power plants (Angola, Botswana, Eswatini, Madagascar, Malawi, Mauritius, São Tomé & Príncipe, Zimbabwe) and wind farms (Angola, Eswatini, Malawi, Mauritius, São Tomé & Príncipe) are the common projects intended to reduce GHGs. Solar technologies are also promoted. In the waste sector, projects include composting (Angola, Eswatini, Madagascar, Mauritius, Mozambique), waste-to-energy biogas (Botswana, Madagascar, Mauritius, Zimbabwe), and waste incineration (Lesotho, Malawi, Mauritius, Zambia, Zimbabwe). Reduction in deforestation and reforestation are prioritized in Angola, Eswatini, Lesotho, Madagascar and Zambia. In the transport sector, countries such as South Africa and Eswatini are focusing on electric mobility, while Botswana and Malawi are developing a shift towards public transport. Energy efficiency measures are among the industrial sector priorities (Lesotho, Namibia, São Tomé & Príncipe, SouthAfrica, Zambia). In the agricultural sector, conservation and smart agriculture practices are being promoted in Lesotho, Madagascar, Malawi and Namibia.

Given South Africa's GHG emissions, mitigation opportunities include carbon capture and storage, nuclear pressurised water reactors, natural gas power and advanced battery storage systems with the integration of solar and wind power. The Lithium-Ion Battery Programme is a step forward for the development of advanced energy storage technologies. The country intends to implement policies and measures such as an ambitious power sector investment plan as set out in the 2019 Integrated Resource Plan, the Green Transport Strategy, enhancing energy efficiency programmes, and the recently implemented carbon tax. In the industry sector, measures such as energy efficiency, improved production processes, fuel switches, and GHG abatement technologies (such as the combustion of methane) are being developed.

Opportunities and challenges for promoting renewable energy

There are significant opportunities to make a low carbon pathway a reality. The fall in cost of renewable technology is a major factor as between 2010 and 2019 the world saw a dramatic decrease in the average global levelised cost of electricity generated from renewable sources. The cost of utility-scale solar photovoltaic (PV) came down by 82 percent, while onshore wind fell by 40 percent[129] , a trend that is expected to continue. This makes renewable energy in most cases the least cost alternative for new electricity generation capacity globally and is a game-changer. Most negative cost mitigation options can be implemented even in households with limited financial resources.

The fact that the regional power system is already well integrated, and the region – and particularly some of the smaller countries – is reaping the benefits of trading in the Southern African Power Pool (SAPP) increases the opportunities[130]. IRENA (2020a) clearly demonstrates that with increased capacity and more routes to trading electricity, power generated from areas with high-quality, cost-effective renewable resources can be distributed more efficiently to meet demand needs in other areas. Additional investments in interconnectors must be clearly evaluated, given that existing physical trading capacity is tied up to a large extent in long-term bilateral trading contracts. The shared power system whose electricity is generated from trans-boundary watercourses provides a major opportunity for regional integration and cooperation, providing synergies enabled by a regional power system integration.

[127] The International Labour Organization (ILO) is spearheading a global "Just Transition" agenda through the Climate Action for Jobs Initiative. The Green Jobs Programme signals ILO's commitment to act on climate change and promote resource efficient and low-carbon societies. Decent work is a cornerstone for effective policies to green economies for achieving sustainable development.

[128] AfDB/UNEP/ECA (2021).

While the SAPP could be a key component in the initiative to enhance electrification to align with climate change objectives, important challenges remain. The quest for regional electricity sustainability involves a delicate balance between national and regional interests. Energy regulations have been progressing across the region with many SAPP countries now having a national regulatory body. However it has been observed that countries tend to favour a sovereign route to self-sufficiency[131], with national power providers dominating in national politics. Even if there are acute shortages, countries do not favour reliance on imports from other countries, perhaps due to a lack of trust[132]. While the role of regional trading mechanisms remains limited, countries tend to favour a bilateral approach, striking long-term supply agreements. In 2016, almost 86 percent of electricity traded in the Southern African Power Pool was bilaterally negotiated[133].

The lack of harmonised policies, frameworks, and regulations in the energy sector and the absence of a clear regulatory framework for decentralised, cross-border transactions renders such cooperation difficult and unpredictable. This calls for an intervention by the Regional Electricity Regulators Association of Southern Africa which was launched in 2002 to support the harmonious development of policy and regulatory frameworks across the region. Regional trade has also been heavily constrained by the lack of adequate transmission infrastructure and there is a deficit in investment. There is a current lack of willingness to liberalise markets while the entry of independent power producers into the power market is vital if private capital is to be mobilised and positive change introduced[134].

Energy policy and long-term planning appears fundamentally inadequate and largely outdated. There is no electricity planning at the regional level. One regional intervention which could have a twin objective is the creation of effective linkages between the energy and industrial development frameworks, with the aim of creating regional energy value chains and building local manufacturing and service capabilities. The lack of a regional initiative on energy is also due to the absence of data and information which remain scarce and of poor quality[135] required for planning and strategy formulation.

There is also a need to invest in building the capacity of practitioners and stakeholders and the development of technical know-how. Expert and diverse teams and stakeholders with up-to-date knowledge, skills and competences is at the core of a successful regional integration.

The transition to renewable energy also involves transitional risks which represent potential economic, social and political barriers to national action on reducing carbon emissions[136]. One such risk includes the overvaluation of assets associated with fossil fuel. An assessment of at-risk investments, physical assets, companies, workers and communities will be essential to design a more efficient transition path, which seeks to minimise the resulting economic, social and political costs.

Energy transition through the blue economy

The ocean is usually viewed as a victim of climate change. However, it is also a source of potential solutions. Ocean-based solutions could reduce the emissions gap — the difference between emissions expected if current trends and policies continue and the level of emissions possible if limiting global temperature increase. Ocean-based activities must be sustainable for the oceans to remain healthy, productive and resilient, yet human activities are impacting them negatively. The concept of the blue economy was born at the 2012 Rio+20 Conference, complementing the evolving development paradigm of a green economy[137]. The blue economy aims at improving human well-being and social equity and preserving the environment through ocean-based activities. It ensures conservation of marine resources, related biodiversity and ecosystems, and offers a sustainability approach to the management of oceans[138].

According to a recent report by the World Resources Institute, ocean-based climate action could deliver up to a fifth (21 percent) of the annual greenhouse gas (GHG) emission cuts needed in 2050 to limit global temperature rise to 1.5°C[139] . The five solutions which the report elaborated are: ocean-based renewable energy; ocean-based transport; coastal and marine ecosystems; fisheries, aquaculture, and shifting diets; and carbon storage in the seabed. Mangroves, salt marshes, and seagrass beds are highly productive vegetated coastal ecosystems, which are referred to as “blue carbon” ecosystems, analogous to “green carbon” ecosystems on land. They are hotspots for carbon storage, with soil carbon sequestration rates per hectare up to 10 times larger than those of terrestrial ecosystems. Despite this potential, only a few countries include these ecosystems in their national GHG inventories and NDC targets.

Different types of food, produced in different places by different means, can vary enormously in the total GHGs they emit across their full life cycle. The composition of global diets, therefore, has a major effect on global emissions. Ocean-based solutions include potentially shifting more GHG-intensive diets to those that include more GHG-friendly seafood options and efficiency gains by reducing waste in the seafood supply chain. Reductions in emissions from wild-capture fisheries can be achieved in a variety of ways including technological advances in engine efficiency.

Six different options for ocean-based renewable energy are identified: wave power, tidal stream power, ocean current power, offshore wind power, Ocean Thermal Energy Conversion (OTEC) and marine floating photovoltaics[140]. These options offer far less intermittency than other renewable resources[141]. Southern Africa is surrounded by energetic seas with high potential for offshore wind and wave power, and possibly even ocean current power. Mozambique seems to have conditions for all studied energy

[129] IRENA. (2020a). Renewable Power Generation Costs in 2019. https://www.irena.org/publications/2020/Jun/Renewable-Power-Costs-in-2019.

[130] IRENA (2020a).

[131] Montmasson-Clair, G., and Deonarain B. 2017. Regional Integration In Southern Africa: A Platform For Electricity Sustainability. Working Paper. Trade $ Industrial Policy Measures. https://www.tips.org.za/research-archive/item/download/1493_7d06ba90f4f77415e4101b6c97fdabcf

[132] Medinilla, A., Byiers, B., and Karaki, K. 2019. African Power Pools Regional Energy, National Power. Political Economy Dynamics of Regional Organisations in Africa. Discussion Paper No.244. https://ecdpm.org/wp-content/uploads/DP-244-African-Power-Pools-1.pdf

[133] Compiled by Montmasson and Deonarain (2017).

[134] IRENA (2015) Analysis of Infrastructure for Renewable Power in Eastern and Southern Africa. International Renewable Energy Agency (IRENA). https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2015/IRENA_Africa_CEC_infrastructure_2015.pdf

kinds, with certain potential for OTEC and wave power. Namibia and Angola have good opportunities too. Offshore wind power and ocean current power are significant opportunities for South Africa. Madagascar offers the potential for wave power, marine floating photovoltaic, offshore wind power, while Namibia and Angola have great potential for offshore wind power.

Mauritius established an integrated framework for the management of fisheries founded on the blue economy concept, which includes coastal zone management and marine biodiversity conservation. The size of São Tomé & Príncipe's exclusive economy zone is nearly 165,000 square kilometres and the accessibility to the ocean from all parts of the island group suggest that oceanic economic sectors can contribute significantly to long-term economic growth. At the same time, the port, airport, oil reservoirs, and hotels are all directly exposed to sea-level rise and coastal incursions. A new or revamped port could reduce some climate risks to the ocean sectors[142] which São Tomé & Príncipe is considering to improve maritime connections.

NDCs can play a critical role in supporting accelerated development of ocean-based energy industry. They can also help to stimulate further investment, research and development for less mature technologies such as tidal, current and geothermal energy. These technologies are particularly relevant for small island developing states as well as coastal countries attempting to lower the energy costs associated with importing liquid fuel[143].

2.2.4. Financial requirements

The development of NDCs with financial requirements is an important step for Southern African countries to have a clear direction on both mitigation and adaptation options. Table 2.11 provides a summary of the climate inflows, needs and gaps. The annual inflows scarcely match the total needs.

Table 2.11 : Climate finance - inflows, needs and gaps (billion USD) (annual)

Countries	Total Inflows	Total Needs	Gap	Mitigation Needs	Adaptation Needs
Angola	0.26	13.01	12.75	8.79	0.03
Bostwana	0.09	0.92	0.83	0.92	0
Eswatini	0.08	0.18	0.10	0.05	0.05
Lesotho	0.11	0.05	-0.05	0.04	0
Madagascar	0.36	2.90	2.55	0.42	1.91
Malawi	0.38	1.48	1.10	1.16	0.28
Mauritius	0.15	0.75	0.59	0.20	0.45
Mozambique	0.62	1.62	0.99	0.76	0.76
Namibia	0.15	0.62	0.47	0.36	0.17
São Tomé & Príncipe	0.08	0.02	-0.06	0.02	0
South Africa	0.39	73.55	73.16	6.40	64.55
Zambia	0.34	3.51	3.17	2.00	1.33
Zimbabwe	0.14	0.61	0.47	0.48	0

2.2.5 Financing options and challenges

Climate finance flows to two primary categories: adaptation and mitigation. As climate impacts will continue to exert economic, social, and environmental costs, adaptation finance focuses on improving preparation and reducing climate-related risk and damage for both human and natural systems. Mitigation finance aims to reduce greenhouse gas emissions, or to remove GHGs already in the atmosphere or ocean, to slow warming and stabilize the climate in the long term. Some financing instruments have dual benefits featuring projects and initiatives that target both mitigation and adaptation outcomes and adaptation[144].

According to Article 4(4) of the UNFCCC, it was clear that developed countries would have to assist developing states to meet the adaptation costs to climate change. To facilitate the provision of climate finance globally, various multilateral and bilateral climate funds were established with a range of financing instruments, including grants, debt, and equity sourced from governments. According to the Climate Policy Initiative Global Landscape of Climate Finance 2021[145], global climate finance flows – including public and private flows of both domestic and international origin – were

[135] IRENA (2005).

[136] Huxham, M., Anwar, M., Nelson, D. 2019. Understanding the impact of a low carbon transition on South Africa. Climate Policy Initiative A CPI Energy Finance Report https://www.climatepolicyinitiative.org/wp-content/uploads/2019/03/CPI-Energy-Finance-Understanding-the-impact-of-a-low-carbon-transition-on-South-Africa-March-2019.pdf

[137] The Green Economy is defined as "improved human well-being and social equity, while significantly reducing environmental risks and ecological scarcities" (UNEP 2012).

tracked at USD 632 billion per year for 2019–2020. These global figures are flows to UNFCCC developing countries as well as other channels and include finance for both mitigation and adaptation. The vast majority (USD 571 billion) of tracked finance flowed to mitigation, with USD 46 billion for adaptation and USD 15 billion for cross-cutting themes that included both. Adaptation finance gained momentum in 2019–2020, increasing 53 per cent to an annual average of USD 46 billion from USD 30 billion in 2017–2018.

Multilateral climate financing to Southern African countries

Data from the Climate Fund Update[146] suggests that there are 16 funds which have provided finance to the 13 southern African countries. Box 2.9 outlines them.

Box 2.9 : Multilateral climate financing to the Southern African countries

Adaptation for Smallholder Agriculture Programme	The Adaptation for Smallholder Agriculture Programme is IFAD's flagship programme for channeling climate and environmental finance to smallholder farmers. The programme is incorporated into IFAD's regular investment processes and benefits from rigorous quality control and supervision systems.
Adaptation Fund	UNFCCC
BioCarbon Fund Initiative for Sustainable Forest Landscapes	The BioCarbon Fund Initiative for Sustainable Forest Landscapes is a multilateral fund, supported by donor governments and managed by the World Bank. It promotes reducing greenhouse gas emissions from the land sector, including efforts to reduce deforestation and forest degradation in developing countries (REDD+), sustainable agriculture, as well as smarter land-use planning, policies and practices. It currently supports programmes in Colombia, Ethiopia, Indonesia, Mexico, and Zambia.
Clean Technology Fund	The $5.4 billion Clean Technology Fund is empowering transformation in developing countries by providing resources to scale up low carbon technologies with significant potential for long-term greenhouse gas emissions savings. Over $4 billion (75 percent of its resources) is approved for implementation in renewable energy, energy efficiency, and clean transport.
EU Global Climate Change Alliance	The Global Climate Change Alliance Plus is a European Union flagship initiative which is helping the world's most vulnerable countries to address climate change. Having started with just four pilot projects in 2008, it has become a major climate initiative that has funded over 80 projects of national, regional and worldwide scope in Africa, Asia, the Caribbean and the Pacific.
Forest Carbon Partnership Facility	The Forest Carbon Partnership Facility is a global partnership of governments, businesses, civil society, and indigenous people's organisations focused on reducing emissions from deforestation and forest degradation, forest carbon stock conservation, the sustainable management of forests, and the enhancement of forest carbon stocks in developing countries, activities commonly referred to as REDD+. The Facility's Readiness Fund helps countries set up the building blocks to implement REDD+ including designing national strategies, developing reference emission levels, designing measurement, reporting, and verification systems and setting up national REDD+ management arrangements, including proper environmental and social safeguards.
Forest Investment Program	The Forest Investment Program empowers developing countries to manage natural resources and achieve a triple win of benefits for forests, for development, and for climate. It provides direct investments to address the drivers of deforestation and forest degradation. It also offers grants and low-interest loans to help governments, communities, and businesses work together to define sustainable solutions for people and economies that rely on forests, while maintaining important ecosystem services.
Global Environment Facility	Funds are available to developing countries and countries with economies in transition to meet the objectives of the international environmental conventions and agreements.
Green Climate Fund IRM	UNFCCC
Least Developed Countries Fund	UNFCCC
Millennium Development Goal Achievement Fund	The Fund was established in 2007 through a landmark agreement signed between the Government of Spain and the UN system with the aim of accelerating progress on the millennium goals

Box 2.9 : Multilateral climate financing to the Southern African countries

Partnership for Market Readiness	The Partnership for Market Readiness is a partnership of developed and developing countries administered by the World Bank, established to use market instruments to scale up mitigation efforts predominantly in middle income countries.
Pilot Program for Climate Resilience	The Pilot Program for Climate Resilience is funded by the Strategic Climate Fund, one of the two Climate Investment Funds. It is designed to demonstrate ways that developing countries can make climate risk and resilience part of their core development planning.
Scaling Up Renewable Energy Program	The Scaling up Renewable Energy Program in low income countries is a targeted program of the Strategic Climate Fund, which is one of two funds within the framework of the Climate Investment Funds. The program was established to scale up the deployment of renewable energy solutions and expand renewables markets in the world's poorest countries.
Special Climate Change Fund	UNFCCC
UN-REDD Program	The UN-REDD Program's aims are to generate the necessary flow of resources to significantly reduce global emissions from deforestation and forest degradation in developing countries and enhance carbon stocks in forests while contributing to national sustainable development.

Table 2.12 and 2.13 show the amount of finance received by the 13 Southern African countries from 2008 to 2021 through multilateral climate financing. Mozambique and Zambia have received the most adaptation finance to date on a grant basis. This is partly as a result of their participation in the Pilot Program for Climate Resilience, which is a multi-year, multi-million-dollar initiative under the multilateral development bank-managed Climate Investment Funds.

Adaptation financing represents 61 percent for the total approved by the 16 climate funds, with mitigation projects amounting to 23 percent. Figure 2.8 excludes South Africa's mitigation and adaptation cost as the significant amount devoted to mitigation would otherwise misrepresent the general proportion between the two categories of costs. The difference between the amount approved and disbursed requires attention. Only seven out of the 16 financing funds (including those which ceased operations) have reached above 70 percent disbursement rates. The Global Environment Facility, Least Developed Countries Fund and Adaptation Fund have respectively disbursed 42 percent, 49 percent and 64 percent. Table 2.14 further shows the disbursement rates at country level. Seven out of the thirteen countries have not reached 50 percent while only four have reached above 60 percent. The sluggish implementation of projects is one area which requires urgent improvement. The next section provides an analysis of the main drivers.

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[144] Climate Funds Update is an independent website that provides information and data on the growing number of multilateral climate finance initiatives designed to help developing countries address the challenges of climate change. Data can be downloaded on https://climatefundsupdate.org/

[145] Climate Policy Initiative (2021). Global Landscape of Climate Finance 2021. https://www.climatepolicyinitiative.org/wp-content/uploads/2021/10/Full-report-Global-Landscape-of-Climate-Finance-2021.pdf (Retrieved on 15 March 2021).

[146] Climate Funds Update is an independent website that provides information and data on the growing number of multilateral climate finance initiatives designed to help developing countries address the challenges of climate change. Data can be downloaded on https://climatefundsupdate.org/

Table 2.12 : Multilateral climate financing to the Southern African countries by types of funds approved vs. disbursed

Funding	Approval date	Concessional loan	Grant	Amount Approved	Disbursed	%Disbursed
Adaptation for Smallholder Agriculture Program (all grants)	2012-2015	0	24.1	24.1	13.0	54%
Adaptation Fund (all grants)	2010-2021	0	54.7	54.7	35.2	64%
BioCarbon Fund Initiative for Sustainable Forest Landscapes (ISFL)	2017	0	8.0	8.0	0.0	0%
Clean Technology Fund	2010-2021	457.4	1.0	458.4	77.3	17%
EU Global Climate Change Alliance	2010-2019	0	59.2	59.2	43.5	73%
Forest Carbon Partnership Facility	2013-2015	0	17.6	17.6	16.0	91%
Forest Investment Program	2017	13.2	15.2	28.4	0.0	0%
Global Environment Facility (all grants)	2007-2022	0	179.7	179.7	74.6	42%
Green Climate Fund IRM	2015-2021	150.0	218.0	367.7	83.4	23%
Least Developed Countries Fund (all grants)	2003-2021	0	193.2	193.2	95.3	49%
MDG Achievement Fund (all grants)	2008	0	7.0	7.0	7.0	100%
Partnership for Market Readiness (all grants)	2011-2015	0	5.4	5.4	3.0	55%
Pilot Program for Climate Resilience	2012-2021	71.9	108.2	180.1	156.3	87%
Scaling Up Renewable Energy Program	2018-2019	19.0	16.9	35.9	25.9	72%
Special Climate Change Fund (all grants)	2007-2013	0	14.2	14.2	14.2	100%
UN-REDD Program (all grants)	2010	0	4.5	4.5	4.5	99%
Total		**711.5**	**926.9**	**1638.1**	**648.9**	**40%**

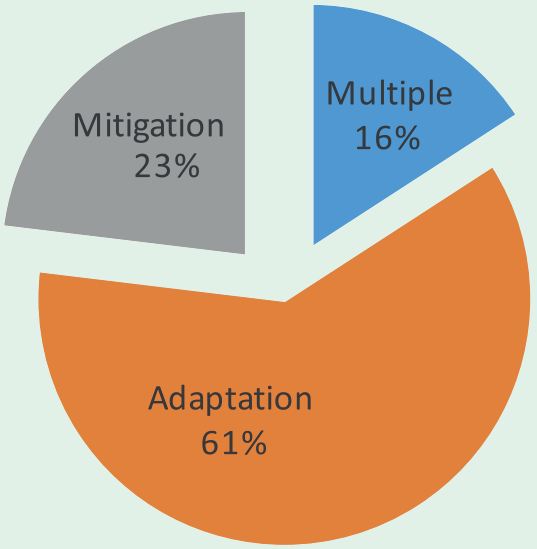
Source: Climate Funds Update [https://climatefundsupdate.org/] (Retrieved 01/03/2022)

Table 2.13 : Multilateral climate financing to the Southern Africa region (by country)

Countries	Concessional loan	Grants	Amount of Funding Approved (USD millions)	Disbursed (USD millions)	% disbursed over approved
Angola	0.0	35.1	35.1	13.4	38.2%
Bostwana	0.0	41.8	41.8	2.2	5.4%
Eswatini	0.0	2.0	2.0	2.0	98.3%
Lesotho	13.0	70.7	83.7	53.7	64.1%
Madagascar	6.0	66.4	72.4	45.2	62.5%
Malawi	0.0	77.5	77.5	35.4	45.6%
Mauritius	0.0	57.6	57.6	29.5	51.2%
Mozambique	49.1	178.8	227.9	141.5	62.1%
Namibia	0.0	95.8	95.8	52.3	54.6%
São Tomé & Príncipe	0.0	11.2	11.2	1.8	15.9%
South Africa	557.4	90.3	647.7	142.9	22.1%
Zambia	86.0	149.2	235.2	112.6	47.9%
Zimbabwe	0.0	50.6	50.3	12.1	24.1%
Total	**711.5**	**926.9**	**1638.1**	**644.5**	**39.3%**

Source: Climate Funds Update [https://climatefundsupdate.org/] (Retrieved 01/03/2022)

Figure 2.8 : Allocation of Climate funds



Notes: Excludes South Africa

Countries that have received climate finance through bilate ral climate initiatives are shown in Table 2.14

Table 2.14 : Main bilateral climate finance initiatives targeting Southern Africa as of January 2022

Fund	Benefactor Countries	Benefaciary countries in Africa
Global Climate Partnership Fund (GCPF)	Germany, UK and Denmark	Namibia (i)
International Climate Initiative (IKI)	Germany	South Africa, Namibia, Malawi Zimbabwe (ii)
MDG Achievement Fund	implemented by UNDP	Mozambique
Nationally Appropriate Mitigation Action Facility	Nationally Appropriate Mitigation Action facility (UK, Germany, Denmark and the EC)	Madagascar, Mozambique, South Africa
Norway's International Climate Forest Initiative (NICFI)	Norway	Zambia, Zimbabwe (iii)
REDD + Early Movers	Germany and UK	Zambia, Malawi, Mozambique, Namibia, Madagascar

Notes : (i) Countries where the GCPF invested in 2020 (ii) Countries where the IKI has running bilateral projects up to date as of January 2022 (iii) NICFI's partner countries for development cooperation.

Sources: Bank staff based on various sources

Challenges to financing climate resilient and low-carbon development

While the first challenge to climate financing is to secure sufficient finance, as per the costing of the NDCs, there are many barriers which urgently require attention at country level. Firstly, at the stage of conceptualisation, the technical and institutional capabilities of governments and stakeholders to develop and design fundable projects has been a major limiting factor in many countries. Adaptation and mitigation projects, being different and complex across several sectors, require several specificities which differ from common investment projects. The types of projects depend significantly on climate scenarios with specific contextual information and their benefits and costs require baseline scenarios, with and without the climate impacts, while mitigation measures necessitate a quantitative assessment of GHG reductions.

The capability, technical competence and skills of governments and stakeholders are limited[147] and together with weak institutional capacity, limited technology, lack of awareness, poor physical infrastructure and unfavourable political environments, many Southern African countries find it difficult to access existing funds. Consequently many projects failed to meet the requirements of bilateral and multilateral donors. The different procedures and standards limit many stakeholders including governments to seek approval for their projects. A further limitation is that a country can only implement adaptation and mitigation projects if capacity exists to do so. For example, in the agroforestry sector, the lack of local expertise and management limit scalability. Given that many mitigation tools are also new and there is often little experience with market-based frameworks, many opportunities are missed. The lack of technical support and limited expertise often prevent approval for mitigation projects, especially given the procedures and standards required.

There is also an opportunity to support the internal capacity of governments to effectively disburse funds from national to local level for implementation. Box 2.10 provides a case where inefficiencies affected the success of a climate resilient project in Mozambique. As regulatory and legal frameworks are very often weak, the lack of an effective governance, monitoring and coordination framework increases inefficiency in implementing projects and often discourages international collaboration, particularly among private sector technology owners and investors.

Box 2.10 : Inefficiencies in climate resilient project – Mozambique

The objective of the proposed Zambezi Valley Market Led Smallholder Development Project is to accelerate poverty reduction within the Central Region of Mozambique and increase the incomes in five districts through broad-based and sustainable agricultural growth. Climate projections for the Zambezi valley conclude the area faces decreasing precipitation (a reduction of about 15 percent), increased potential evaporative losses (about 15-25 percent) and diminished run-off (about 30-40 percent) which will have substantial negative impact on land use and household livelihoods. The project has four components: (a) strengthening community groups, organisations and local institutions; (b) agricultural production and marketing development; (c) developing a community agricultural and environmental investment fund; and (d) project management, coordination and monitoring and evaluation. Strategies included development of agroforestry technologies and energy efficient technologies, crop diversification with native and high value species, and increasing resilience towards climate variability[148].

In 2016, a project assessment report was published by the World Bank Group. [149]The relevance of the project's design was modest. The project's results framework was inadequate, since it lacked causal chains to show how the project's activities would lead to intermediate outcomes and link to the development objective. According to project assessment data, the average increase in household income for the project beneficiaries was 36 percent higher than the average recorded at baseline. However, for the control group, the average increase in household income was 69 percent compared with the average income recorded at baseline. Other aspects of the project proved highly inefficient: project coordination and monitoring costs increased by 92 percent over the course of the project, owing to management inefficiencies (failed baseline surveys, changing staff). The project's quality at entry was rated moderately unsatisfactory because of inadequate attention to the lessons of previous community-driven development approaches. These lessons would have argued for additional time and attention to targeting, group formation, capacity-building, and improved decision-making capabilities.

Mitigation management often involves the coordination of research and development (R&D) as well as the adoption of new technologies and practices. There is increasing needs for fiscal instruments designed by governments to implement adaptation and mitigation measures. Strong R&D plays a significant role in the fast increase in renewable energy as well as the adoption of sustainable agricultural practices. However, limited R&D on renewable energy technologies has been observed.

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2.2.6. Tapping into innovative financing instruments

The Global Landscape of Climate Finance 2021 report concluded that climate finance increased by 10 percent in 2019/2020, compared to 24 percent in the previous period. The COVID-19 pandemic affected the mobilisation of adaptation finance, not only delaying existing adaptation plans in many developing countries with health restrictions and other measures, but also diverting financial resources towards the health sector and supporting other economic sectors. Adaptation finance increased by 53 percent during the same period but despite this remains far below the scale needed for existing and future climate change. Estimates suggest that an increase of at least 590 percent is required. In this respect, innovative financing instruments are necessary to scale up both mitigation and adaptation

The conventional approach the report takes, consistent with much of the climate finance field, is to focus on primary infrastructure investment mostly by the public sector. Scaling finance for activities to other stakeholders remains largely unexploited. Several financial instruments have been proposed but their implementation has been slow. In this section, several such instruments are identified. These are: debt-for-nature and debt-for-climate swaps, green bonds, carbon markets including blue carbon pricing, instruments geared towards private finance and climate risk management initiatives. These instruments could accelerate progress towards building climate resilience, economic development, and averting further impacts by curtailing fossil fuel use, and conserving ecosystems.

Debt-for-nature and debt-for-climate swaps

For severely indebted Southern African countries, potential exists to finance their debts through debt-for-nature swaps. Debt-for-nature vehicles are typically a voluntary transaction in which an amount of hard currency debt owed by a developing country government (debtor) is cancelled or reduced (i.e. discounted) by a creditor, in exchange for financial commitments to deliver nature key performance indicators, by the debtor[150]. Debt-for-climate swaps, involve a debtor nation committing to greater climate ambition for domestic climate activities on terms agreed with the creditor instead of continuing to make[151] external debt servicing payments. The debt servicing payments that are saved would then be used to achieve agreed climate resilience or protection of biodiversity that also contribute to poverty reduction. Madagascar is one example where a debt-for-climate swap is highly relevant. Table 2.15 provides a summary of the transactions for debt-for-nature swap between 1989 and 2018, for four Southern African countries.

Such swaps have been identified as a promising opportunity to generate fiscal space for countries promoting green and resilient investment and are particularly suited to countries with high levels of bilateral public external debt with other countries but are currently not captured by the G20 Debt Service Suspension Initiative. However, they are complex in their implementation due to high transaction costs, requirements for long-term financial commitments, and possibility of inflation or local currency devaluation in the debtor country. There are also challenges in the design and implementation of conservation projects with concrete performance indicators.

Table 2.15 : Debt for nature swap

Three party Debt-for-Nature transactions excluding TFCA						
Country	**Purchaser**	**Year**	**Cost**	**Currency**	**Face Value of Debt**	**Conservation Funds Generated**
Madagascar	US	1989-2008	1989-2008	1989-2008	1989-2008	30949
Zambia	US	1989	1989	1989	1989	2500
U.S. Bilateral Debt-for-Nature transactions Under TFCA						
Country	**Purchaser**	**Year**	**Cost**	**Currency**	**Face Value of Debt**	**Conservation Funds Generated**
Bostwana	US	2006	7000	USD	n.a	8300
Countries other than the United States participating in bilateral and multilateral Debt-for-Nature initiatives						
Debtor Country	**Creditor**	**Year**	**Cost**	**Currency**	**Face Value of Debt**	**Conservation Funds Generated**
Madagascar	Germany	2003	n.a	USD	25092	14843
Mozambique	France	2015	n.a	euros	17500	2000
Mozambique	Germany	2014	n.a	euros	n.a	10000
TFCA means Tropical Forest Conservation Act 1998 in the US						

Source: Sheikh, P. A. 2018. Debt-for-Nature Initiatives and the Tropical Forest Conservation Act (TFCA): Status and Implementation. Congressional Research Service.

Green and climate bonds

A range of other financing options is emerging. Green bonds are increasingly becoming popular as a financial instrument for environmental projects. The proceeds raised from the bond issue are used to finance projects and assets that have environmental benefits such as energy efficiency, renewable energy, low-carbon transport, green buildings, smart grids, climate-smart agriculture and forestry, among many other initiatives. When green bonds reduce the cost of capital for green projects, even if only marginally, this is likely to improve the conditions for green investments[152]. The first issuer of green bond in Africa is South Africa, as a municipal green bond issued by the cities of Cape Town and Johannesburg.

Namibia also issued a three-year green bond in December 2018 through the Bank of Windhoek, and became the first commercial lender to offer a green bond in Southern Africa. The proceeds are expected to fund eligible green projects and assets that fit renewable energy, pollution prevention and control, energy efficiency and clean transport criteria. The AfDB, the International Bank for Reconstruction and Development and the International Finance Corporation (a member of the World Bank Group), are among the small number of important players in the green bonds market in Africa.

There is also the emergence of a related instrument - the climate policy performance bonds. As the name suggests, these bonds are linked to the performance of carbon emissions reduction or increase in production of renewable sources of energy. The government issuing it promises to pay less than the market rate of interest if commitments are met, and if the government is unable to meet its commitment, then interest paid is greater than the market rate.

Carbon credits and markets

One important issue in relation to climate finance negotiations is assessing the amount of carbon that countries emitted in the past and allocating the remaining carbon budget. There is increasing global consensus that by limiting future emissions and setting commitments equitably, including finance, countries can quantify the "common but differentiated responsibilities" for historical climate damage. The amount of carbon debt and credit for the 13 South African countries are shown in table 2.16[153].

Table 2.16 : Cumulative carbon emission debt and credit at international average carbon price (USD billions)

Countries	Carbon credit	Carbon credit	Annual compensation 2022-2050
Angola	67.03	148.95	5.32
Bostwana	0.14	0.32	0.01
Eswatini	1.74	3.88	0.14
Lesotho	2.56	5.69	0.2
Madagascar	67.49	149.98	5.36
Malawi	48.26	107.24	3.83
Mauritius	0.74	1.64	0.06
Mozambique	77.72	172.71	6.17
Namibia	2.74	6.1	0.22
São Tomé & Príncipe	0.45	1	0.04
South Africa	366.42	814.26	29.08
Zambia	43.26	96.14	3.43
Zimbabwe	23.07	51.27	1.83

Source: Staff calculations

[150] https://www.cbd.int/doc/nbsap/finance/Guide_Debt_Nov2001.pdf.

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[152] Marbuah, G. 2020. Scoping the Sustainable Finance Landscape in Africa: The Case of Green Bonds. Stockholm Sustainable Finance Centre. https://www.stockholmsustainablefinance.com/wp-content/uploads/2018/06/SSFC_greenbonds_africa_report.pdf (Retrieved on the 17th March 2020).

[153] The amount is based on the 2020 average international energy market carbon price of $31 a ton and the average social cost of carbon of $70 per ton suggested by the High Commission on Carbon Prices, as well as the suggested 2 percent per year discount rate for historical and future emissions.

The 13 Southern countries represent 15.1 percent of Africa's total carbon credit of USD 4.58 – USD 4.8 trillion, averaging USD 4.64 trillion, considering historical, current, and future shares of carbon emissions. Countries such as Angola, Madagascar, Malawi, Mozambique, South Africa, Zambia and Zimbabwe have huge carbon debt using the discounted social cost of carbon. This means that they should receive a significant climate change compensation per year under "common but differentiated responsibilities" principles accounting for historical climate damage

Carbon credits and markets have gained popularity over recent years. Carbon credits are generated from emission reduction projects (such as a solar farm or forest conservation easement) or pollution allowances allocated by government cap-and-trade systems. The credits are then sold to buyers, often a private company or government, looking for cost-effective ways to cut emissions or meet a target[154]. For example, South Africa initiated the Carbon Offsets imitative in June 2019, which assists firms to cost-effectively reduce their emissions and carbon tax liability by up to 10 percent of their total greenhouse gas emissions by investing in low carbon, mitigation projects[155]. These carbon offsets are expected to create an estimated market of between 10 and 20 million tons of CO_2 per year, while providing investment for real mitigation projects throughout South Africa[156]. Carbon markets turn emission reductions and removals into tradeable assets. Carbon markets have grown strongly over the last years to attract carbon finance in the form of clean development mechanism financing. Other multilateral, state-funded approaches to carbon finance might become available in the future through article 6 of the Paris Climate Agreement, allowing countries to meet their emission targets and protect these carbon-rich habitats.

Recently, there is a growing interest in establishing carbon credits from conserving and restoring terrestrial forests as a component of climate change mitigation, incorporating these activities within the UNFCCC and related mechanisms such as the Reducing Emissions from Deforestation and Forest Degradation (REDD+). These approaches are further broadened to manage other natural systems that contain rich carbon reservoirs — including coastal ecosystems — and reduce the potentially significant emissions from their conversion and degradation and to activate the carbon markets. One example is the blue carbon option which represents an opportunity for mangroves, saltmarshes, seagrasses, and wetlands restoration projects to receive carbon credits on the voluntary carbon market. Box 2.11 provides the findings of the benefits of blue carbon from the study by Zheng et al. (2021). Given the natural resources in many Southern Africa region, carbon credits could be a wise option to conserve and restore ecosystem and biodiversity.

Box. 2.11 : Blue carbon financing

Mangroves, saltmarshes and seagrasses store carbon and provide numerous benefits including providing fish habitat, shoreline protection, biodiversity, and other ecological and socio-economic functions. Zheng et al. (2021) conducted a study on the climate mitigation potential and benefits that mangrove blue carbon can contribute at the national level for Madagascar, Mozambique and Angola. This scale matches the scale of NDC by signatories of the Paris Climate Agreement to reduce national emissions and adapt to the impacts of climate change. The findings are as follows.

Mangrove blue carbon

Countries	Extent (ha)	Climate mitigation potential (tCO_2e $year^{-1}$)	Net present value (US$ $year^{-1}$)
Madagascar	71600 (±1600)	1,557,000 (±158,000)	92,629,000 (±9,997,000)
Mozambique	7500 (±300)	63,000 (±9,000)	3,326,000 (±540,000)
Angola	900 (±100)	29,000 (±4,000)	1,294,000 (±214,000)

The two indicators climate mitigation potential and net present value provide the basis for new financing mechanisms which are geared towards protecting the ecosystems for the benefits of the population.

Source: The Blue Carbon Initiative. Blue Carbon Framework 2.0 Executive Summary. https://static1.squarespace.com/static/5c7463aaa9ab95163e8c3c2e/t/5cc29d487817f7de2f222a50/1556258121464/2012-02_Blue_Carbon_Policy_Framework_20_Executive_Summary.pdf

Herr, D., Himes-Cornell, A., Laffoley, D. National Blue Carbon Policy Assessment Framework Towards effective management of coastal carbon ecosystems. International Union for Conservation of Nature.

Zheng, Y., Friess, D. A., Sarira, T. V., Siman, K., Pin Koh, L. 2021. Global potential and limits of mangrove blue carbon for climate change mitigation Current Biology 31, 1737–1743.

[154] https://qz.com/2079710/how-would-a-global-carbon-market-work/#:~:text=What%20is%20a%20carbon%20market,cap%2Dand%2Dtrade%20systems

[155] https://www.gov.za/speeches/national-treasury-amendments-carbon-offsets-regulations-20-jul-2021-0000

[156] http://promethium.co.za/#:~:text=Carbon%20offsets%20are%20carbon%20credits,administration%20system%20for%20these%20offsets.

[157] Hofmann, M. and Khatun, K. (2012). Facilitating the financing of bioenergy projects in sub-Saharan Africa. Energy Policy, Elsevier, vol. 52(C), pages 373-384.

[158] Rumble, O. & First, J. 2021. Accelerating Private Sector Climate Finance in Africa. Briefing 249, October.

Carbon markets are generally complex to develop because of a range of barriers and risks[157] including: inexperience with and uncertainty about the global carbon markets and certified emission reductions in international offset markets; widespread inadequate capacity and expertise; high and increasing transaction costs (applicable to all types of projects, but particularly negative for small-scale carbon projects); and a smaller (and decreasing) number of large-scale carbon project opportunities. The host country's risks (financial and regulatory), additionality issues (at validation stage) or underperformance due to faulty monitoring or delays in issuances are barriers which can be commonly recognised in Southern African countries.

Private sector climate finance

The Global Landscape of Climate Finance 2021 report further pointed out that the public sector continues to provide almost all adaptation financing, with adaptation increasingly being prioritised in development finance climate portfolios. However, both public and private investment are needed to align development objectives with the Paris Agreement. Private sector climate finance is yet to be fully developed in Southern Africa region and can be accelerated through providing concessional finance in the form of credit enhancement mechanisms in projects related to climate-smart agriculture, renewable energy, energy efficiency and waste management. Credit enhancement mechanisms can be provided by entities that provide concessional finance in the form of guarantees, tenure extension mechanisms, lower-than-market pricing and subordinated loans[158].

In order to effectively build climate resilience and ensure an energy transition in Southern Africa, private actors (households, non-financial corporations, commercial financial institutions, institutional investors) must be involved through a variety of financing channels and instruments[159]. For instance, capital markets and banking may shift toward green loans and a mixture of private equity, venture capital, and infrastructure funds. Funding mechanisms include:

• Project finance[160]: typically involving direct debt or equity investments in a single project; can be fully commercial, or forms of concessional finance could include loan guarantees, first loss debt, and off-taker guarantees;

• Financing facilities: involve debt or equity funding for a pool of projects, companies, or individuals (as opposed to single projects); can offer varying levels of concessionality including subordinate debt or equity, longer debt tenors or fund horizons, or supplemental grant capital.

• Results-based finance: involves debt or grant capital for a project or portfolio of projects that is contingent on the achievement of a certain climate adaptation outcome.

• Liquidity instruments: grant or debt facilities designed to provide immediate access to capital; typically established to help governments, businesses, or individuals cover their immediate needs in the wake of a major event.

• Insurance: the most common form of risk transfer, it captures catastrophe bonds, parametric insurance, index insurance, and risk pooling.

Climate finance and green investment also provides the best ground on which to apply blockchain (e.g. fintech), combining technology and finance[161]. The capitals for a renewable energy project which are currently only coming from banks would be channelled through technology to foster collaboration between the industry and finance.

Climate risk management initiatives

One important barrier to the low private sector involvement in adaptation and resilient building projects is the failure to comprehensively integrate climate-related risk into capital investment planning. The extent to which markets can price and absorb climate risks remains an issue that has received limited attention in Africa. Part of the reason lies in the lack of disclosure of climate-related risk data.

Physical risks are actual climate change effects, such as increased frequency of extreme weather (e.g. storm surges) that damage infrastructure or disrupts seasonal demand . When extreme weather events such as drought and flooding impact on economic sectors, its costs will impact on investors, entrepreneurs, farmers or on the insurance sector. One example is the Cyclone Idai which in 2019 affected Mozambique, Malawi and Zimbabwe. Of the USD 200bn losses, only 7 percent were covered by insurance. On the liability side, physical risk increases insurance costs, and default rates or credit losses. There is also a risk of not properly calculating or underestimating insurance risk premiums due to the uncertainty of climate impacts. As the frequency and severity of weather events increase, climate risks would have to be efficiently integrated in investment decisions. Investing in physical risk reduction measures (e.g. irrigation systems or flood defenses) and pre-arranging risk finance means the insurance industry will be a key player. For private finance to flow into resilient infrastructure, as with mitigation projects, risk transfer solutions and pre-arranging risk finance underwritten by insurance companies are required. Insurers enabling necessary solutions and allowing access to individuals, businesses and governments is vital to ensuring climate resilience[163].

Transitional risk occurs when economies shift to renewables, green markets and products. The risk includes policy changes, reputational impacts, and shifts in market preferences, norms, and technology.

Physical and transitional risks can impact the financial sector, on the basis of invested assets, infrastructure funds and corporate bond holding[164], the wide range of valuation differences over stranded assets, and over potential declines in market valuations and book values of corporate assets on intermediaries' balance sheets[165]. Over the years, new types of insurance which factor weather risk has emerged in the African continent. Two examples are provided in box 2.12 and 2.13.

[159] CPI, 2019. Global Landscape of Climate Finance 2019 [Barbara Buchner, Alex Clark, Angela Falconer, Rob Macquarie, Chavi Meattle, Rowena Tolentino, Cooper Wetherbee]. Climate Policy Initiative, London. Available at: https://climatepolicyinitiative.org/publication/ global-climate-finance-2019/

[160] Morgan Richmond, June Choi, Rajashree Padmanabhi, Amanda Lonsdale, 2021. Financial Innovation for Climate Adaptation in Africa. Global Center on Adaptation/Climate Policy Iniative.

[161] Marke, A., and Sylvester, B. 2018. Chapter 4. Decoding the Current Global Climate Finance Architecture. Transforming Climate Finance and Green Investment with Blockchains. Academic Press ISBN: 9780128144473.

Box 2.12 : Agriculture and Climate Risk Enterprise

The Agriculture and Climate Risk Enterprise is the largest input-linked, mobile-enabled index insurance programme in Africa. It is not an insurance company but is rather a service provider working with local insurers and other stakeholders in the agricultural insurance value chain. Smallholders buy agricultural inputs from agri-business business partners and are linked to the insurance programme via a mobile application (by scanning a code). The premium is 50 percent subsidised for the smallholder farmers who pay only half the premium; and the other half is paid by the enterprise's agribusiness partners. During a climate crisis, compensation for yield loss is triggered immediately via a mobile money transfer service. Solar-powered local weather stations which regularly update the weather conditions are installed near individual farms to calculate the impact of the event and respective pay-outs. By 2018, over 1,700,000 farmers in Kenya, Tanzania, and Rwanda insured over USD 180m against a variety of weather risks underwritten by various insurance companies. Crops insured include maize, sorghum, coffee, sunflower, wheat, cashew nuts, and potato, with coverage against drought, excess rain, and storms.

Source: ACRE website 2022 https://acreafrica.com/about-us/
Climate Policy Initiative
https://www.climatepolicyinitiative.org/gca-africa-adaptation-finance/case_studies/agriculture-and-climate-risk-enterprise-acre-2/

In this respect, the introduction of novel collaborative instruments between the private and public sector should be welcomed, especially to de-risk adaptation and mitigation investment and reduce the investment risk. Example of such instruments include credit guarantees, export credits, hedging products such as currency and interest swaps, political risk insurance, public catastrophe and weather risk, insurance as well as the associated research, pilot projects, and the data collection that underpins local index-based insurance[166].

[162] OECD (2021). Financial Markets and Climate Transition Opportunities, Challenges and Policy Implications, OECD Paris. https://www.oecd.org/finance/Financial-Markets-and-Climate-Transition-Opportunities-challenges-and-policy-implications.htm

[163] https://www.fsdafrica.org/news/the-role-of-insurance-in-climate-change-and-sustainable-development/

[164] Krauss, A. D. 2021. Chapter 16. Effect of climate change on the insurance sector, The Impacts of Climate Change. Elsevier Inc. https://doi.org/10.1016/B978-0-12-822373-4.00014-8

[165] OECD (2021).

[166] AfDB (2018). Gap Analysis Report: African Nationally Determined Contributions (NDCs) African Development Bank

Box 2.13 : African Risk Capacity

The African Risk Capacity (ARC) was established by the African Union (AU) in 2012 as an African-owned, index-based weather risk insurance pool and early response mechanism that combines the concepts of early warning, disaster risk management, and risk finance. ARC's mission is to develop a pan-African natural disaster response system that enables African governments to meet the needs of people at risk of natural disasters. The expected impact of ARC is to offer African countries competitive pricing for insurance products[a] through a pooled insurance model. At the national level, it should improve the ability of governments to better anticipate, plan, and respond to disaster risks by strengthening capacities, awareness, and action around disaster risk management (DRM). Finally, at the local level, vulnerable households should be more resilient to disasters as they receive timely support.

Pathway 1: When a disaster hits, the timely insurance pay out, coupled with the effective implementation of contingency plans, will enable governments to respond more effectively to support vulnerable households. By ARC 'supporting timely and effective response' by governments, vulnerable beneficiary households will reduce their loss of assets and livelihoods following a shock.

Pathway 2: Through dialogue and capacity-building, ARC can positively influence the policy and practices of member states around disaster risk management (DRM). By ARC's capacity of 'influencing policy and practice of member states', African Union member countries will be better able to anticipate, plan, finance and respond to climate-related disasters in a timely, effective manner.

Pathway 3: Through dialogue and coordination with the broader DRM community in Africa, ARC will be 'creating increasing value/demand for ARC products and services' among non-member states.

Because payouts are based on pre-defined rainfall triggers, ARC delivers payouts to governments within 2-4 weeks of the end of the agricultural growing season. According to cost-benefit analyses commissioned by ARC, reaching households within three months could result in nearly $1,300 per household in protected livelihoods, and each £1 invested in early intervention through ARC saves £4.40 in traditional humanitarian costs. Furthermore, by collectively pooling and diversifying their risks across the continent, countries save up to 50 percent in the cost of emergency contingency funds. How has this theory translated into practice? Following the severe drought that hit the Sahel in early 2015, Senegal, Niger and Mauritania received payouts from their coverage which arrived weeks before the UN appeal was even launched. Knowing that a payout was coming, governments could update their response plans and assist vulnerable groups straight away. A total of USD 26.3 million was used to purchase livestock fodder and staples, primarily from local producers, benefiting about 1.3 million people[b].

Source: aScott, Z., Simon, C., McConnell, J., Villanuava, P. S. 2017. Independent Evaluation of African Risk Capacity (ARC) Final Inception Report. Oxford Policy Management. https://reliefweb.int/sites/reliefweb.int/files/resources/African-Risk-Capacity.pdf
bhttps://www.results.org.uk/sites/default/files/files/October%202016%20Background%20Sheet%202.pdf

CHAPTER 3

POLICY PRIORITIES TO RECOVER FROM COVID-19 AND EMBARK ON GREEN GROWTH PATHWAYS

There is an urgent need to align climate resilient and clean energy development in achieving the SDGs, including access to energy and water, reduction in poverty and income inequality, and thereby meeting the Paris Agreement targets. As governments prioritise readjustments after the COVID-19 pandemic and lay the foundations for their financial, economic, and social recovery, they have a unique opportunity to create more sustainable economies, inclusive, and resilient. To enable such synergies, this section focuses on the policy priorities in the short-, medium-, and long-term to embark on a green growth pathway.

3.1 Short-term measures

Short-term measures aim at creating the enabling environment to accelerate climate resilience and a just energy transition towards development objectives and SDGs, to spearhead economic recovery from the COVID-19 pandemic.

3.1.1 Strategically aligning NDCs with national development plans and SDGs

First, there is a need for strategic alignment of NDC projects with national development plans and wider sustainable development goals to establish employment-generating and wealth-creation opportunities. Renewable energy, climate smart agriculture, disaster risk management and coastal adaptation measures can all spur economic activities in the medium and long-term and are all income and employment generating activities, through their direct and indirect employment multipliers. South African countries could initiate such alignment by involving ministries and departments to integrate the NDCs into their agendas and objectives as well as adopting a participatory approach based on consultation with stakeholders.

3.1.2 Establishing government framework for climate financing

To accelerate the approval and disbursement of climate funds, there is an urgent need to establish an efficient governance framework to develop and implement projects, and monitor their outcomes and funds disbursed to local departments. The necessary institutional arrangements have received limited attention and the current state could be detrimental to tapping into funds in future. Policy studies to date have identified the importance of strengthening partnerships and collaborations, cross-sector dialogue, and actions by the establishment of inter-ministerial climate change committees and task forces to manage the impacts of climate change. In the short-term, South African countries need to establish governance frameworks based on stakeholder involvement, transparency and accountability. The governance framework needs to ensure that the funds are efficiently disbursed to the vulnerable groups, e.g. women, farmers, coastal residents, to strengthen their resilience towards slow-onset climate change as well as immediate climate-related disasters.

3.1.3 Developing capacity and skills for climate mitigation and adaptation

An essential step to accelerate climate resilience and energy transition is to build the necessary human capacity and skills within Southern African countries. This involves capacity-building of government bureaucrats, private sector stakeholders and NGOs to design and implement adaptation and mitigation projects, integrating state-of-art intervention with local ecological knowledge. Employees in financial institutions, private sector enterprises and government entities must be trained to evaluate and act on climate risks in their business agendas. Secondly, skill development, training and education are also required to equip the labour force, farmers, women, and youth to implement mitigation and adaptive measures on a larger scale. There is an urgent need to strengthen the capacity of vulnerable groups, including women to adapt to climate change risk. International assistance such as the ILO and the United Nations Institute for Training and Research, as well as local training institutions could play a key role.

3.2 Medium-term policies and measures

Medium-term measures are aimed at scaling up climate action in different sectors - climate smart agriculture, water, fisheries, energy, health, among others - and to involve stakeholders at large.

3.2.1 Mainstreaming resilience and energy transition plans in investment decision-making

It is important that climate risk should be integrated in investment decision-making processes at all levels. For instance, enterprises investing along an agricultural supply chain or infrastructure investors building water, energy and telecommunication facilities will be operating in a sector with substantial climate risk but may not be screening for it nor mitigating that risk. The same applies to carbon-intensive companies. These enterprises will require climate change transition plans consistent with the Paris Agreement[167], and would benefit from government and wider international support. Small and medium-size enterprises (SMEs) offering adaptation-relevant products and services should be empowered to unlock climate adaptation solutions and to develop "bankable" projects. Public and private decision-makers would benefit by integrating climate change considerations into development planning, which becomes a prerequisite to mobilize domestic funding and access funding from the Green Climate Fund and a necessary step to climate-resilient development.[168]

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3.2.2 Promoting private and innovative climate financing

Adaptation and mitigation will require more and more a blending of public, private, domestic, and international finance. Funding mechanisms and models that could smartly blend adaptation and mitigation financing sources, and flexibly support multi-objective climate-smart initiatives would support climate action. Private financing will play a key role and therefore in the medium-term, it is crucial that the enabling environment be put in place to fund bankable projects and secure financing in a transparent manner involving government agencies and the private sector. This will be highly beneficial to countries struggling to juggle high debt burdens, high climate vulnerability and limited access to credit such as Madagascar.

3.2.3 Fiscal incentives aligned with climate financial instruments

Governments are required to invest in policy incentives to scale up adaptation and mitigation projects at local, national and regional levels and accelerate towards useful interventions. For instance, renewable energy tax and investment incentives (financial and administrative in nature) can be considered as well as the inclusion of negative externalities of use of fossil fuels in its cost through taxation and elimination of subsidies (where applicable).

3.2.4 Promoting climate risk management initiatives

As the future economic outlook is highly linked to climate change risk, there is a need to promote climate risk management initiatives especially to vulnerable groups in rural areas. Women are an important targeted group as they are most likely to be the driver towards climate resilient development especially at household and community level. Countries requiring such initiatives include Madagascar, Malawi, Mozambique, Zambia and Zimbabwe, where women are mostly employed in the agricultural sector.

3.2.5 Migration policy towards climate change

Migration will intensify in the face of natural hazards and countries must develop migration policies to prevent significant unplanned migration which can be detrimental to both migrants and local communities. Climate action should be encouraged to enhance the protection of displaced people and maximise positive mechanisms of migration across and within countries through capacity-building, research and policy, legal advice, and norm development. Policy on climate-induced or environmental migration could be a priority for countries such as South Africa and Mozambique.

3.3 Long-term measures

Long-term measures aim at impactful climate outcomes at regional and perhaps global levels.

3.3.1 Towards a just transition

To support a smooth and just transition – including fair division of the costs energy transition creates –decent work and social protection policies must be tailored to the specific needs of each country and region. Social equity considerations, particularly on gender, must be integrated into policy and an eventual programme of climate adaptation and mitigation. An assessment plan to cater for the transition risks will be essential to prevent minimise ensuing economic, social and political costs.

3.3.2 Reforming and harmonising the regulatory and institutional environment

The effective implementation of measures and policies from the NDCs would require regulatory and institutional reforms at country level. Dedicated and coordinated efforts in this direction are likely to contribute to overall sustainability during and after reform efforts, especially in the electricity sector. There is a need to restructure electricity tariffs to enable power suppliers, energy service providers and grid operators to meet their financial commitments while

[167] This is also one of the proposals of 2021 Global Investor Statement to Governments on the Climate Crisis coordinated by the seven Founding Partners of The Investor Agenda [https://theinvestoragenda.org/wp-content/uploads/2021/05/IN-CONFIDENCE_EMBARGOED_2021-Global-Investor-Statement-to-Governments-on-the-Climate-Crisis-1.pdf

[168] AFDB/UNEP/ECA (2021) ibid Chapter 7 Conclusions: A Report That Fuels The Call For Economic Action.

maintaining and expanding their grids as demand increases. There is also an urgent need to accelerate the harmonisation of policies, frameworks, and regulations in the energy sector. In fact, the absence of a clear regulatory framework for decentralised, cross-border transactions renders such operations difficult and unpredictable and represents a major barrier to developing the Southern African Power Pool.

3.3.3 Building synergies between mitigation and adaptation measures

There are important linkages between mitigation and adaptation measures. Adaptation options with mitigation or development co-benefits should be encouraged, such as deploying renewable energy sources which contribute to mitigating emissions, as well as strengthening the resilience of the energy sector to heat extremes and droughts. The use of solar-powered, efficient micro-irrigation can greatly increase farm incomes, improving yields and reducing water usage while also offsetting carbon by generating clean energy. These types of projects should be identified urgently in the short-term to be implemented in the medium-term.

3.3.4 Enhancing collaboration and cooperation

The transition to clean energy and decarbonising the key sectors of energy, transportation, and infrastructure needs collaboration at an unprecedented scale. The African electricity market is one area where collaboration must be further developed by building on existing regional power pools in order to balance load curves and stabilise neighbouring countries' grids. The introduction of large-scale variable renewable energy capacity would reduce the cost of electricity through trade and reduce overall greenhouse gas emissions. This is particularly relevant to countries such as Angola and Malawi with limited connectivity to the rest of the region and those which aim to develop their exports such as Mozambique, South Africa, Namibia and Zambia. Collaboration and cooperation avenues must be further developed and materialized.

3.3.5 Implementing climate-related innovation and smart solutions

Innovative and smart solutions that would combine climate smart technologies, market design, regulatory frameworks, and system operations should be implemented on a large scale. Innovative business services over a continuum of on-grid, mini-grid and off-grid models are capable of extending access to modern energy at a large scale and are highly beneficial to countries with very low access to electricity such Madagascar, Malawi and Mozambique. They will also help Botswana, Lesotho, Zambia, and Zimbabwe, countries facing tough challenges to promote electricity access equitably between urban and rural populations. Universal expansion of telecommunication infrastructure, information and communication technology and clean electricity will be imperative to embrace a digital transformation to support industrialisation. The use of technology will be a pre-requisite to monitor, measure and respond to climate impacts in different sectors such as agriculture, water, health, fisheries. In the long term, the necessary infrastructure and institutional framework must be completed and fully operational.

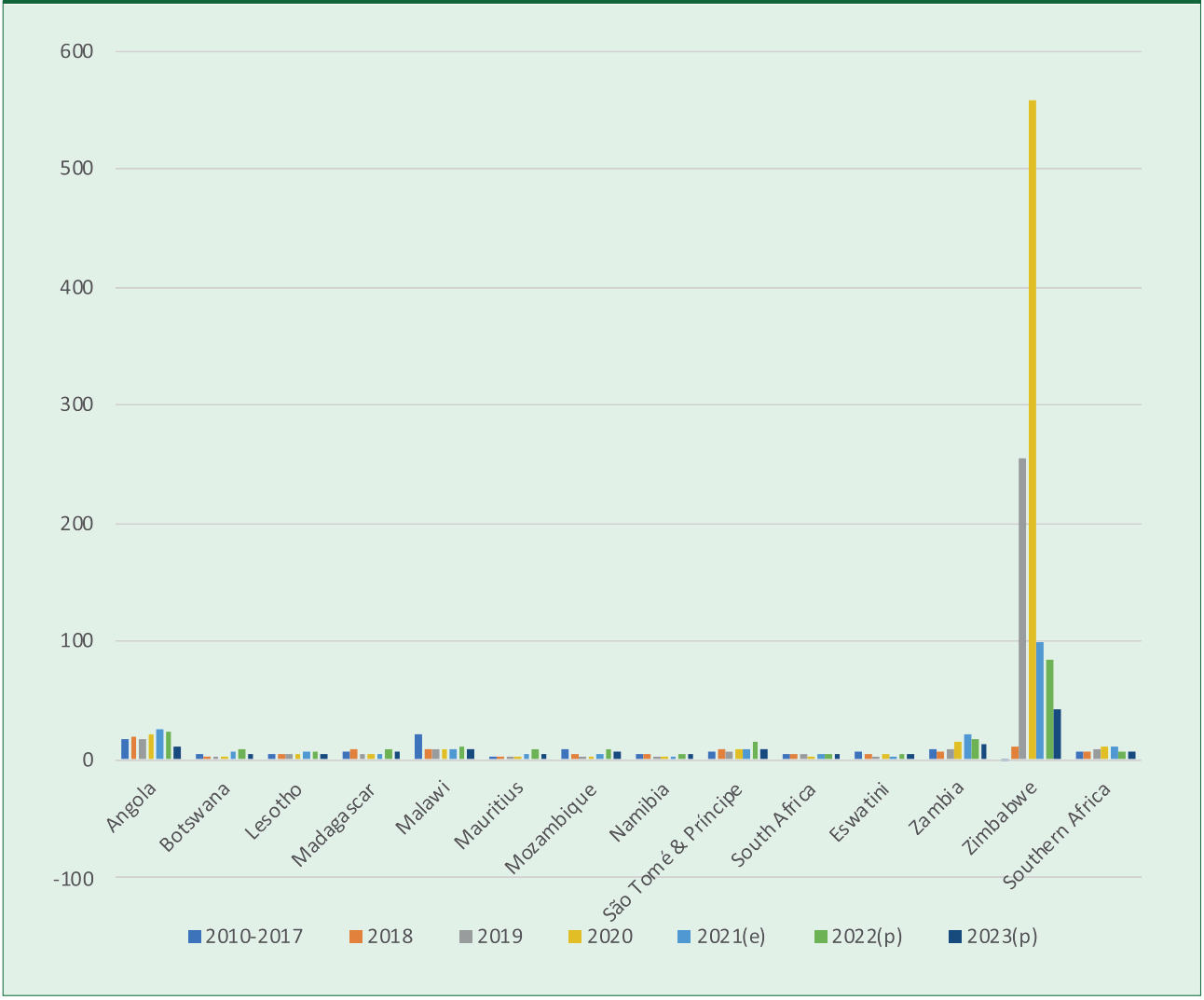
3.3.6 Ensuring gender participation in climate compatible development

Extreme weather events such as droughts and floods have a greater impact on the poor and most vulnerable, and a large percentage of the world's poor are women. Women must fully be empowered to participate in the transformation in the long term and should therefore be at the heart of this transition.

[167] This is also one of the proposals of 2021 Global Investor Statement to Governments on the Climate Crisis coordinated by the seven Founding Partners of The Investor Agenda [https://theinvestoragenda.org/wp-content/uploads/2021/05/IN-CONFIDENCE_EMBARGOED_2021-Global-Investor-Statement-to-Governments-on-the-Climate-Crisis-1.pdf]
AFDB/UNEP/ECA (2021) ibid Chapter 7 Conclusions: A Report That Fuels The Call For Economic Action.

APPENDIX

Appendix 1.1 : Inflation in Southern Africa by country, 2010-23 (percent)



Notes: Excludes South Africa

Appendix 1.2 : Fiscal, Monetary and Exchange Rate Policy

Country	Fiscal policy	Monetary policy	Exchange rate and balance of payment
Angola	The National Assembly approved revenue and expenditure measures to fight the COVID-19 outbreak and minimize its negative economic impact. About US$40 million on additional health care spending was announced and about US$80 million are being spent on 250 Cuban doctors who arrived in Angola to help. Tax exemptions on humanitarian aid and donations and some delays on filing taxes for selected imports were granted. On July 28 2020, the National Assembly adopted a conservative supplementary budget, aiming at securing space for additional health expenditure, while balancing the need to keep debt on a sustainable path. The 2021 budget consolidated the non-oil revenue gains and expenditure restraint of the 2020 budget, while protecting priority health and social spending. On May 17 2021, additional US$ 33 million were approved for purchase of 4 million vaccine doses through the African Union.	In March 2020, the central bank (BNA) reduced the rate on its 7-day permanent liquidity absorption facility and expanded its credit-stimulus programme to selected sectors. Financial institutions were requested to grant their clients a moratorium of 60 days for servicing debt. On April 3 the BNA increased the minimum bank credit allocation to producers of priority products and instructed banks to provide credit in local currency to assist importers of essential goods. On May 7 2020, the BNA reinstated its Permanent Overnight Liquidity Provision facility to provide liquidity support to banks (Kz 100 billion), and extended access to large non-financial corporations on a discount line created to purchase government securities. However, with inflation steadily rising and the worst of the shock seemingly passing, the BNA shifted to a gradual tightening in the second half of 2020. Actions included the enhanced use of open market operations to drain excess liquidity from the system and an increase in the reserve requirement on banks' foreign exchange deposits (to be settled in domestic currency) in September. In March 2021, the BNA implemented additional measures to control inflation, including increasing the 7-day permanent liquidity absorption facility (reversing the cut in the same rate made in March 2020) and, in May 2021, again increased the reserve requirement on banks' foreign exchange deposits. In June 2021, BNA requested the financial institutions to grant companies of the mostly impacted sectors by the pandemic (transport, tourism and sports), a moratorium of up to 6 months for servicing debt.	On April 1 2020, the central bank introduced an electronic platform for foreign exchange transactions. By May 2021, the transactions between the largest players, including oil, diamond, Treasury and BNA, were carried out on the platform. Exchange rate futures were also traded in the platform.
Botswana	The government established a COVID-19 Relief Fund with a 2 billion Pula (about 1.1 percent of GDP) contribution from the government that will: i) finance a wage subsidy amounting to 50 percent of salaries of affected businesses (1000-2500 pula per month for a period of 3 months; ii) finance a waiver on training levy for a period of 6 months (150 million pula). The MoF also offered a tax deferral of 75 percent of any quarterly payment between March and September 2020 to be paid by March 2021; iii) Build-up of fuel and grain	At the meeting held on April 30, 2020, the Monetary Policy Committee (MPC) of the Bank of Botswana decided to reduce the Bank Rate by 50 basis points from 4.75 percent to 4.25 percent to support the domestic economy, and reduced the primary reserve requirement from 5 percent to 2.5 percent to inject liquidity. The bank rate was further reduced by 50 basis points on October 8. Banks and non-banks have agreed to offer loan restructuring (including for mortgages and vehicles) and payment holidays for affected sectors. Life insurance payment premiums and	The Bank of Botswana will implement a new annual downward rate of crawl of 2.87 percent with effect from May 1st 2020, representing a change from the current 1.51 percent. This is complementary to the reduction in the Bank Rate and contributes to further easing of real monetary conditions in the economy.

Appendix 1.2 : Fiscal, Monetary and Exchange Rate Policy

	reserves, as well as acquisition of relevant medical equipment and improvement of water supply (475 million Pula); iv) Fund a government loan guarantee scheme of 1 billion Pula (20 percent financed by commercial banks) for businesses that are tax compliant (including those who are not eligible to pay taxes). Guarantee covers a period of 24 months with a max of 25 billion pula per borrower. Reduce the VAT refund period (from 60 days to 21 days).	retirement fund contributions have been rescheduled for at least three months. The Bank of Botswana relaxed rules to meet capital requirements and introduced measures to improve liquidity. The capital adequacy ratio for banks has been reduced from 15 to 12.5 percent, and regulatory forbearance for non-performing loans. Overnight funding costs were reduced, access to repo facilities broadened, collateral constraints for bank borrowing from the Bank of Botswana extended to include corporate bonds and traded stocks, and electronic payments transaction limits have been raised.	The Bank of Botswana will implement a new annual downward rate of crawl of 2.87 percent with effect from May 1 2020, representing a change from the current 1.51 percent. This is complementary to the reduction in the Bank Rate and contributes to further easing of real monetary conditions in the economy.
Lesotho	Introduced quarterly warrants to contain non-pandemic spending to create space for pandemic spending. Tax Policy Administration: Company income tax filing season extended to the end of September 2020. Social Mitigation: The authorities spent LSL213.5 million on pandemic-related social assistance (around 0.7 percent of GDP) for up to three months in FY20/21. Measures included : Increasing existing benefits (LSL50.1 million, 0.2 percent of GDP). The government topped up cash transfers to existing beneficiaries (50,000 existing households under the Child Grants Program and 12,741 existing destitute families under the Public Assistance Programme) by LSL831 per month (Jul–Sep 2020). Payments to new beneficiaries (LSL112.1 million, 0.3 percent of GDP). Under the Public Assistance Programme, cash transfers (LSL831 per month) were provided to 10,000 newly destitute families (Jul–Sep 2020) and 45,000 persons aged 60–69 (May–Jul 2020). Food security (LSL46.0 million, 0.1 percent of GDP). Cash support to beneficiaries in privately-owned care facilities housing (1,335 children, 23 elderly	On March 23, 2020, following an extraordinary meeting of the Monetary Policy Committee (MPC), the Central Bank of Lesotho (CBL) announced (i) an increase of the NIR target floor from US$630 million to US$660 million, and (ii) a reduction of the CBL policy rate by 100 basis points from 6.25 to 5.25 percent. To encourage the use of non-cash payments, the CBL has negotiated with mobile network operators the removal of fees for transactions below M50 and temporarily raised mobile money transaction limits. On April 14, following another extraordinary meeting of the MPC of the CBL, it announced a reduction of the CBL policy rate from 5.25 to 4.25 percent. On May 22, the CBL further cut its policy rate to 3.75 percent and reduced the NIR floor from US$660 million to US$530 million. On July 28, the CBL cut its policy rate by another 25 bp to 3.50 percent and raised NIR floor from US$530 million to US$550 million. The MPC further raised the NIR floor to US$635 million on November 24, to US$670 million on January 26, to US$720 million on March 30, and further to US$800 on May 24 to safeguard the peg between the Loti and the South African Rand. Additional financial sector measures were also adopted: (i) Banks were directed to suspend loan repayments for three months, and insurance companies to suspend premium payments. At the end of June, the bank-related measures were extended to September; (ii) The implementation of Basel II.5 was postponed to enhance the banks' capacity to lend; (iii) Banks and insurance companies were instructed not to pay dividends to shore up capital and liquidity; and (iv) the CBL used moral suasion to encourage banks to reduce fees on digital platforms.	No measures. The local currency is pegged to South Africa's Rand, which depreciated substantially during the first few months since the COVID-19 outbreak but gradually recovered later on.

Appendix 1.2 : Fiscal, Monetary and Exchange Rate Policy

	persons, and 651 persons with disabilities) (May–Jul 2020). Food parcels for vulnerable households (up to 100) across community councils (Jul–Sep 2020). Food stamps to vulnerable Basotho living in South Africa (9,000–12,000) (Jun 2020). Food and/or cash transfers (LSL831 per month) to acutely vulnerable households (72,626) with livelihoods affected by poor planting and COVID-19 mitigation measures. Under the School Feeding Programme, take-home rations for early childhood care and development and primary school-going vulnerable children (72,200) (May–Jul 2020) Gender and sports (LSL5.2 million, < 0.1 percent of GDP). Support to gender-based violence survivors. Stipends for 14 premier league clubs Cash grants for athletes in other sporting codes. Economic Mitigation Measures: LSL698 billion (about 2 percent of GDP) for National COVID-19 Secretariat for the National COVID-19 Response Integrated Plan 2020, more than half of which was used for health care personnel and purchase of critical goods and services, with the remainder covering logistics, security, and border management, as well as helping informal-sector vendors (LSL500 per vendor), covering business rent for May 2020 and providing 75 percent partial credit guarantee for firms. LSL130 million agricultural subsidy, up to 60 percent subsidy on agriculture inputs for summer cropping. LSL170 million salary subsidy for textile industry workers ; (iv) LSL50 million grant scheme to MSMEs, especially in tourism (LSL20,000 matching grant to companies with less than 50 employees). LSL1.5 million for other measures (including PPE).		

Appendix 1.2 : Fiscal, Monetary and Exchange Rate Policy

Madagascar	Key measures include: (i) targeted investments to strengthen the health system following the activation of the national contingency plan in coordination with the WHO to protect against the pandemic; (ii) expansion of social assistance to the most vulnerable, including cash-transfers and in-kind support to the poorest and those unemployed; and (iii) supporting private sector through tax relief, suspension of government fees and waived social contributions. As of end of July 2020, medicine and medical equipment were exempted from paying import duties.	The central bank provided monetary policy support and acted to safeguard financial stability. The central bank is providing liquidity to the commercial banks, reaching MGA 609 billion (about 1.2 percent of GDP) at end December 2020 and relaxed some mandatory deposit limits to encourage banks to defer delayed payments on existing loans and increase lending to businesses.	The authorities maintained the flexible exchange rate regime. Based on the latest available data, the central bank has made interventions in response to market tensions on the foreign exchange market and large fluctuations in the EUR-USD exchange rate, and in 2020 the exchange rate depreciated respectively by about 5 percent vis-à-vis US$ and 16 percent vis-à-vis EUR€.
Malawi	The government's response plan includes US$39 million (0.3 percent of GDP) in spend on health care and targeted social assistance programmes; this includes hiring additional health care workers. In addition, tax waivers are being granted on imports of essential goods to manage and contain the pandemic. An Emergency Cash Transfer Programme of about $50 million (0.5 percent of GDP), mostly financed by development partners, was implemented during May-November.	The Reserve Bank of Malawi reduced the policy rate by 150 basis points to 12 percent. The domestic currency Liquidity Reserve Requirement (LRR) has been reduced by 125 basis points to 3.75 percent (aligned with the foreign currency LRR) and the Lombard Rate has been reduced to 12.2 percentage points, 0.2 percentage points above the policy rate. An Emergency Liquidity Assistance (ELA) framework has been introduced to support banks in the event of worsening liquidity conditions and to provide support to banks on a case-by-case basis. However, financial sector buffers, including bank capital and liquidity buffers, are expected to counter risks to the banking system. To support small and medium enterprises (SMEs), commercial banks and micro-finance institutions will be, on a case-by-case basis, restructuring SME loans and providing a moratorium on their debt service until end-June 2021. Fees on mobile money transactions have been temporarily waived to encourage cashless transactions.	No measures have been taken.
Mauritius	At the beginning of the COVID-19 outbreak, the authorities announced plans to increase general public health spending by Rs1.3billion (0.28 percent of GDP). A range of fiscal support measures have also been taken to limit the socio-economic impact of the pandemic. The on-budget measures include the implementation of a wage subsidy to employers under the Wage Assistance Scheme (GWAS) – for employees drawing a monthly basic wage of up to Rs 50,000 subject to a cap of Rs 12,500 per	The Bank of Mauritius (BOM) reduced the Key Repo Rate from 3.35 percent to 2.85 percent in March 2020, followed by a further reduction to 1.85 percent in April 2020. In March 2020, the BOM also adopted a set of measures focused on economic operators which are being directly impacted by COVID-19, including: i) reduction of the cash reserve ratio from 9 to 8 percent, with the amount released through the reduction to be made available to affected economic operators; ii)a special credit line of Rs5 billion (1.2 percent or 2020 GDP) through commercial banks for affected firms to meet their cash flow and working capital requirements ; iii) commercial banks also introduced a moratorium of six months on capital	After allowing for some initial depreciation of the Rupee in 2020Q1, the BOM substantially limited exchange rate flexibility by intervening on the foreign exchange market to cover the significant shortage of foreign exchange caused primarily by the halt in tourism. Before the end of the first half of 2021 the depreciation of the Rupee vis-à-vis the USD has accelerated while FX sales interventions continued. In tourism. Before

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employee, as well as income support under the Self-Employed Assistance Scheme (SEAS) for those employed in the informal sector or self–employed who received Rs 5,100 per month. Since July 2020, the schemes covered only employees in the tourism sector. It was announced that the support to the sector would continue until the opening of borders, with some Rs23.5 billion being used as of June 2021. Throughout the lockdown in March 2021, the support was also provided to other sectors as half month's payment, as well as a one-off grant of Rs 10,000 to the self-employed. In April 2021, as reopening started, the full month's assistance was provided under both GWAS and SEAS for all sectors. The schemes were extended until September 2021 for tourism-related companies. In addition, the government is to provide Rs9 billion support to Air Mauritius (the national airline) from its National Resilience Fund. In October 2020, it was announced that Rs9 billon would be redirected to limit the increase in unemployment. As a result, from November 2020, until the end of June 30 2021 five initiatives were funded: i) The Human Resource Development Council (HHRDC) increased the national training and reskilling intake by some 9,000 unemployed in the construction, manufacturing, logistics, ICT-BPO, agro-industry, renewable energy and the circular economy. Beneficiaries are paid monthly stipends of Rs10,200 over a training period spanning six months; ii) an Employment Support Scheme for SMEs to support 11,000 employees with a monthly payment of Rs10,200 per capita; iii) Recruitment by Landscope (Mtius) Ltd of some 2,000 technically unemployed people for the National Clean-Up Campaign; iv) The Air Freight Scheme, incorporated into the Economic Recovery Plan, has two components: supervision for the national airline, currently under voluntary administration and support for the export sector. To support the most vulnerable following a new lockdown, electricity was made free for March and April for repayment for existing loans of affected economic operators; iv) the BOM also eased supervisory guidelines on handling credit impairments; and v) Rs5 billion (1.1 percent of GDP) of 2.5 percent two-year BOM savings bonds which were made available to retail investors.

In March 2020, BOM announced additional support measures: (i) six-month moratorium on household loans at commercial banks, while BOM would bear interest payments for households with the lowest income; (ii) Special Foreign Currency (USD) Line of Credit (initially $300 million, extended by $200 million) targeting operators with foreign currency earnings, including SMEs; (iii) swap arrangement to support import-oriented businesses (initial amount $100 mill); and (iv) Shared ATM Services - waving ATM fees during national confinement period.

In September 2020, BOM announced the extension to December 31 2020 of the moratoria granted to economic operators (including Small and Medium Enterprises), households and individuals under its COVID-19 Support Programme. The terms and conditions of the moratoria remained unchanged. In December 2020, these, together with other measures falling under the Support Programme, were further extended to June 30 2021, and subsequently to June 30 2022.

Following the amendments to the BOM Act adopted by the parliament as part of COVID Bill on May 15 2020, the BOM Board approved the following additional measures in late May 2020: 1) a one-off exceptional contribution of Rs60 billion (14 percent of 2020 GDP) for the purpose of assisting Government in its fiscal measures to stabilize the economy of Mauritius; 2) setting up the Mauritius Investment Corporation Ltd (MIC) as a Special Purpose Vehicle with two-fold objectives: (i) mitigate the spread of the ongoing economic downturn to the banking sector, thus limiting macro-economic and financial risks; (ii) secure and enhance financial wealth for current and future Mauritian generations while ensuring the stability of the banking sector. BOM announced that it would invest $2 billion of FX reserves in MIC towards the latter objective. It has also been announced Mauritius Investment Corporation (MIC) will focus on investing in the pharmaceutical and blue economy as the end of the first half of 2021 the depreciation of the Rupee vis-à-vis the USD has accelerated while FX sales interventions continued. In addition, BOM conducted swap transactions with commercial banks under its support programme for import-oriented businesses for an initial amount of $100 million, later enlarged by another $100 million available until December 2020. Furthermore, it has also provided the State Trading Corporation Ltd (STC) with FX to ensure adequate supply of essential goods to the public.

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individuals under the Social Register of Mauritius (SRM) or under the National Empowerment Foundation (NEF), as well as low-consuming SMEs, and at 46 percent discount for the following four months. The government has also established a COVID-19 Solidarity Fund aimed at funding COVID-19 related projects (financial support to Mauritian residents and the financing of projects related to the COVID-19 virus and other related health issues), primarily relying on donations from the public and enterprise, however this fund is quite small at roughly Rs 500 million.

Regarding off-budget measures, the Development Bank of Mauritius Ltd (DBM) is to provide Rs10.2 billion (2.3 percent of 2020 GDP) in credit to distressed enterprises and cooperatives. The State Investment Corporation has raised Rs4 billion (0.9 percent of 2020 GDP) to make equity investments to troubled firms, including SMEs. All labour contracts set to expire this year have been extended through December 2021.

In terms of revenue measures, the Mauritius Revenue Authority introduced a tax relief, where tax payments with due date falling between November 2020 and May 2021 were deferred to the end of June 2021.

To support a green recovery, the new budget 2021/22 lays out various green initiatives. A sum of Rs 2.2 billion (Rs 5.3 billion over a five-year horizon) is allocated to the National Environment and Climate Change Fund, to rehabilitate the coastlines, strengthen environmental monitoring, clean up the country, and promote greening the economy. To turn green energy industry into a new economic growth pole, the target is to produce 60 percent of the country's energy needs (currently at Rs 20 billion) from green sources by 2030, with use of coal totally phased out before 2030.

new strategic sectors. As of April 30 2021, the MIC has been provided with Rs80 billion in financing by the BoM, of which Rs3.75 billion has been disbursed by June 10 2021.

In mid-March 2021, additional financial support has been put in place to support SMEs through the new lockdown: (i) An SME Interest-Free Loan Scheme in the amount of Rs100,000, without interest rate and a 5-year moratorium for SMEs with less than Rs50 million turnover; (ii) the One Million SME COVID Special Support Scheme by DBM, with loans of up to Rs1 million, without a guarantee, at 0.5 percent interest rate p.a. The DBM also granted an extended loan moratorium period of one year to all SMEs.

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Mozambique	Early on, the government has asked Mozambique's development partners for US$ 700 million to help deal with the economic impact of the pandemic. This fiscal package would finance: (i) temporary and well-targeted tax exemptions to support families and the health sector (VAT and import tariff exemptions on food, medicine and medical equipment); and (ii) higher spending to respond to the health crisis and humanitarian needs, including higher health-related spend on goods and services, and higher cash transfers and subsidies to the poorest households as well as micro-businesses and SMEs. In May, the government extended the VAT exemption on sugar, vegetable oil and soap until the end of the year. Some emergency expenditure was delayed by the government due to a review following appropriate budgetary procedure and putting in place a revised budget, which has been approved by the general assembly in early November 2020.	To ease liquidity conditions, the central bank reduced reserve requirements by 150 basis points in March 2020 for both foreign currency and domestic currency deposits (to 11.5 percent and 34.5 percent respectively). It announced measures to support financial markets and encourage prudent loan restructuring by: (i) introducing a foreign currency credit line for institutions participating in the Interbank Foreign Exchange Market, to the amount of US$ 500 million, for a period of nine months; and (ii) waiving the constitution of additional provisions by credit institutions and financial companies in cases of renegotiations of the terms and conditions of the loans, before their maturity, for clients affected by the pandemic, until December 31. In March 2020, the central bank announced measures to ease payment system transactions and liquidity conditions by: (i) lowering fees and charges for digital transactions through commercial banks, mobile banking and e-currency, for a period of three months, and (ii) waiving specific provision on foreign currency loans, until December 31. In April 2020, the central bank introduced the requirement for exporters to exchange 30 percent of FX proceeds into domestic currency. In 2020, the central bank reduced the policy rate by 250 bps to 10.25 and lifted the twice-a-week access restriction on the standing lending facility introduced in October 2016. However, with the exception of FX conversion requirements and the exemption from constituting additional provisions that was extended until end-June 2021, the measures were waived and the central bank increased its policy rate by 300 basis points in January 2021 to 13.25 percent.	The Metical has depreciated by about 15 percent against the US dollar between early March 2020 and January 2021. Following the increase in the policy rate in January, the trend of depreciation had temporarily reversed in January-April 2021, with sharp nominal appreciation vis à vis the dollar of about 22 percent. However, as of June 15, the Metical has depreciated by 6.5 percent since April. No major capital flow movements have taken place, while international reserves have remained relatively stable over the past months.
Namibia	On April 1 the government launched the Economic Stimulus and Relief Package to mitigate the impact of COVID-19 (8 billion Namibian Dollars, or 4.25 percent of GDP), including: i) expenditure measures of 2.6 billion for health, wage subsidies for affected sectors, and income grants; and ii) guarantees of up to 2.3 billion to support low interest loans for small and agricultural businesses, and individuals. On June 15, the government announced it will extend the deadline of submitting individual income tax returns from June 30 to September 30 (not the payment of taxes due, which remains June 30). In August the	The central bank reduced the policy rate by 25 basis points to 3.75 percent on August 19 2020 (250 bps total since the state of emergency was declared). On March 26, the central bank announced changes in the financial sector and its regulatory setting, including: i) allowing banks to grant loan payment moratorium (payment holidays) ranging from 6 to 24 months, ii) regulatory and policy relief changes, such as relaxing the determination on liquidity risk management, reducing the capital conservation buffer rate to 0 percent for at least 24 months to support banking institutions to supply credit, and postponing the effective date of implementation of the 25 percent single borrower limit and concentration risk limit.	No measures

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	Bank of Namibia announced it will participate in the operationalization of the loan guarantee programme, providing 50 million Namibian dollars in capital targeted to SME credit.		
São Tomé & Príncipe	Key measures include: (i) Implementation of the health contingency plans prepared in coordination with the WHO and increased health spending (on medicine, equipment, staffing, and treatment centers) to protect against COVID-19; (ii) Expansion of social assistance to the most vulnerable, including expansion of the WB-supported cash-transfer programme, and increased support to the disadvantaged (the elderly, disabled and abandoned children); (iii) Protecting small businesses and employment, in particular through salary contributions; (iv) Financial assistance to workers who lost their jobs in both the formal and informal sectors; (v) Implementation of automatic stabilizers; (vi) Where supply chains are disrupted, the state procured seeds, feedstock, and other essential inputs to be sold to farmers at market price; (vii) Introduction of a solidarity tax on workers, including public servants, whose salaries are relatively unaffected by the shock.	The Central Bank of São Tomé (BCSTP) has reduced the policy rate and minimum cash reserve requirement, and temporarily eased some prudential ratios for three months to ensure adequate provision of liquidity in the market. The BCSTP has encouraged commercial banks to reduce some banking fees and grant a temporary moratorium on debt repayments for fundamentally sound businesses affected by the crisis. They are also working on options to increase liquidity to banks so that they will be able to grant credit to the economy and have established, in coordination with the AfDB, a new credit line for banks to provide lending to small and medium enterprises affected by the pandemic.	No measures.
South Africa	The government assisted companies and workers facing distress through the Unemployment Insurance Fund (UIF) and special programmes from the Industrial Development Corporation. UIF benefits, which had been extended until January 2021, were further extended until April 2021. Additional funds were made available for the health response to COVID-19, workers with an income below a certain threshold received a small tax subsidy for four months, and the most vulnerable families received temporarily higher social grant amounts until end of October 2020. A new temporary COVID-19 grant, created to cover unemployed workers that do not receive grants or UIF benefits, was extended through April 2021. The number of food parcels for distribution was increased and additional funds were allocated in	The central bank (SARB) reduced the policy rate progressively during the pandemic, by 100 basis points on March 19 2020, another 100 basis points on April 14 2020, 50 basis points on May 21 2020, and 25 basis points to 3.5 percent on July 23 2020. On March 20 2020, the SARB announced measures to ease liquidity conditions by: (i) increasing the number of repo auctions to two to provide intraday liquidity support to clearing banks at the policy rate; (ii) reducing the upper and lower limits of the standing facility to lend at the repo rate and borrow at 200 basis below the repo rate; and (iii) raising the size of the main weekly refinancing operations as needed. On March 23 2020, the government announced the launch of a unified approach to enable banks to provide debt relief to borrowers. On March 25 2020, the SARB announced further. measures to ease liquidity strains observed in funding markets. The programme aims to purchase government securities in the secondary market across the entire yield curve and extend	The SARB maintains its longstanding practice of not intervening in the foreign exchange market.

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	the 2021 budget for public works programmes. Funds were made available to assist SMEs under stress, mainly in the tourism and hospitality sectors, and small-scale farmers operating in the poultry, livestock, and vegetables sectors including a new 1.2 billion Rand Tourism Equity Fund announced in late January 2021. An official loan guarantee scheme was introduced to provide bank loans guaranteed by the government, to eligible businesses to assist them during the pandemic with operational expenses. The scheme has been extended until July 11 2021 to allow loans already in process to be drawn and facilitate an orderly wind down. Allocations were made to a solidarity fund to help combat the spread of the virus, with the assistance of private contributions, and to support municipal provision of emergency water supply, increased sanitation in public transport, and food and shelter for the homeless. The revenue administration accelerated reimbursements and tax credits, allowing SMEs to defer certain tax liabilities, and issued a list of essential goods for a full rebate of customs duty and import VAT exemption. A four-month skills development levy tax holiday was also implemented.	the main refinancing instrument maturities from 3 to 12 months. On March 26 2020, the SARB issued guidelines on modalities to provide debt relief to bank customers. On March 28 2020, it announced temporary relief on bank capital requirements and reduced the liquidity coverage ratio from 100 to 80 percent. On April 6 2020, the SARB issued guidance on dividend and cash bonuses distribution to ensure bank capital is preserved. Effective May 11 2020, the SARB returned the number of repo auctions to once a day and, on May 12 2020, announced a series of prudential priority measures for cooperative financial institutions on prudential matters, supervisory activities, and governance and operational issues. On August 3 2020, the SARB announced that macro-prudential policy easing would be extended until further notice. As of August 19 2020, as liquidity conditions normalized, the SARB reverted to standard standing facility borrowing rates (the repo rate less 100 basis points). On February 3 2021, the SARB decided to revert to discretionary end of day supplementary repurchase operations at the repo rate.	
Eswatini	In FY21/22 the government has budgeted E200 million to procure vaccines for Eswatini's entire population, which it is planning to use to purchase vaccines through the AU. As the vaccines received thus far have been donated, these funds have not yet been used. In FY19/20 (ending March 31 2020), a supplementary budget was approved for additional public healthcare of E100 million (0.14 percent of GDP). In addition, the authorities have put in place a response package in FY20/21 of E1 billion (1.5 percent of GDP) to increase healthcare capacity, ramp up food distribution and social protection transfers, and improve access to water and sanitation facilities for the most vulnerable. Food assistance has been provided, benefiting over 360,000 people. Low priority recurrent spending will be redirected to the fight against	The Central Bank of Eswatini (CBE) has: (i) reduced the discount rate by a cumulative 275 basis points to 3.75 percent and has kept it unchanged; (ii) reduced the reserve requirement to 5 percent (from 6 percent); (iii) reduced the liquidity requirement to 20 percent (from 25) for commercial banks and to 18 percent (from 22) for the development bank; (iv) encouraged greater use of electronic payments; and (v) encouraged banks to consider loan restructuring and repayment holidays. The authorities have also begun enhancing their liquidity management framework and tools, and on July 15, issued a notice outlining new facilities and changes to existing ones. Banks have announced that those individuals and companies that need short-term financial support or relief can approach them and each application will be assessed on a risk-based approach. The CBE's regulatory relief measures for banks in response to COVID-19 expired on December 31 2020.	No measures

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	the pandemic and a portion of the capital budget will be reallocated towards refurbishing hospitals and completing new hospitals. The government has set up a revolving fund of E45 million (0.07 percent of GDP) to assist SMEs, and a E25 million (0.04 percent of GDP) relief fund to aid laid off workers, E12.8 million of which has been disbursed to unemployed workers thus far. Revenue measures to mitigate the impact of the virus include: (i) taxpayers projecting losses will file loss provisional returns and no payment will be required; (ii) extension of returns filing deadlines by three months before penalties start ; (iii) payment arrangements for taxpayers facing cash flow problems; (iv) waiver of penalties and interest for older tax debts if the principal is cleared by the end of September 2020; and (v) up to E90 million (0.13 percent of GDP) in tax refunds for SMEs that have complied with tax obligations, retain employees, and continue to pay them during this period. The authorities have reduced the price of fuel twice and postponed the planned increase in water and electricity prices. The government is also subsidizing the cost of required COVID-19 tests for informal cross-border traders, many of whom are women whose livelihoods depend on this trading activity.		
Zambia	Import duties on mineral concentrate and export duties on precious metals were suspended to support the mining sector (the first measure was extended permanently with the 2021 Budget). The government has waived tax penalties and fees on outstanding tax liabilities resulting from COVID-19. It has suspended customs duties and VAT on some medical supplies and medical-related commodities. It has also removed provisions related to claiming VAT on imported spare parts, lubricants, and stationery, in order to ease pressure on companies. The government has also issued an 8 billion kwacha bond (2.3 percent of GDP) to finance COVID-19 related expenses, including health spending, arrears clearance,	The Bank of Zambia's (BoZ) Monetary Policy Committee lowered the policy rate by 225 bps to 9.25 percent on May 19 2020, and by 125 bps on August 19 2020, to mitigate the adverse impact of the pandemic. The BoZ provided 10 billion kwacha (2.9 percent of GDP) of medium-term liquidity support to eligible financial services providers. It also scaled up open-market operations to provide short-term liquidity support to commercial banks and embarked on a bond purchase programme worth 8 billion kwacha to provide liquidity to the financial sector. In addition, the BoZ implemented several measures to stimulate the use of e-money and reduce the use of cash, revised the rules governing the operations of the interbank foreign exchange market to support its smooth functioning by strengthening market discipline and and providing a mechanism to address heightened volatility,	No measures

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	grain purchases, and a recapitalization of a non-bank financial institution (NATSAVE). The 2021 Budget envisions zero rating under the VAT for equipment used for full body sanitization for a period of one year, as well as tax breaks for tourism: a permanently lower CIT rate and suspended import duties and fees.	revised loan classification and provisioning rules, and extended the transitional arrangement to IFRS9.The BoZ has allowed financial service providers to renegotiate the terms of credit facilities with borrowers affected by the pandemic. Non-bank financial institutions were allowed to use capital instruments that do not qualify as common equity Tier 1 and Tier 2 capital for the purposes of computing regulatory capital.	
Zimbabwe	The authorities have set aside US$100 million for the vaccination programme to be complemented by donations. The country has received 800,000 vaccine donations from China. Discussions are ongoing to procure vaccines from India, Russia, the EU, the US, COVAX and African Union. The vaccination programme also is also targeting the mass vaccination of the Victoria Falls resort city to boost tourism. In 2020, the Ministry of Public Service Labour and Social Welfare assisted 309,000 labour constrained and food poor households through COVID-19 cash transfers (ZWL$754 million). While the 2021 planned interventions by the Ministry on COVID-19 have a ZWL$450 million budgeted allocation, there are no disbursements to date. The freeze on government hiring was lifted for the health sector, targeting over 4,713 additional medical personnel (about 20 percent increase). Additionally, the authorities introduced a risk allowance to the health sector from April 2020 (ZWL$468 million/year), and a civil service wide COVID-19 risk allowance for the period June–December 2020 (ZWL$20.3 billion). Companies were allowed to delay the payment of corporate taxes (waiving interest and penalties). Duties and taxes on various goods and services related to COVID-19 were suspended to facilitate speedy procurement of essential goods and services, with revenue forgone in 2020 amounting to US$483 million. In support of the tourism sector, the authorities exempted VAT on domestic tourists accommodation and exempted VAT on visitor services.	In March 2020, the authorities returned to the multicurrency system allowing both Zimbabwean dollar and US dollar to be legal tender. In 2020, the RBZ introduced a ZWL$5 billion medium-term bank accommodation lending facility at 10 percent per annum and increased the private sector lending facility from ZW$1 billion to ZW$2.5 billion. Beneficiaries have included the mining, tourism, manufacturing, and construction sectors. Funds were also set aside for supporting empowerment programmes for SMEs, artists and sports, Zimbabwe Women Microfinance Bank, People's Own Savings Bank and the Small and Medium Enterprises Development Company. In its February 2021 Monetary Policy Statement, the central bank adjusted some of the policies that it was implementing to cushion firms from the COVID-19 protection effects. The statutory reserve ratio on demand and/or call was pegged back to 5 percent after having been lowered from 5 to 4.5 percent in March 2020, and further lowered from 4.5 percent to 2.5 percent in June 2020. The RBZ policy rate was increased to 40 percent after being lowered from 35 percent to 15 percent per annum in March 2020 and 35 percent in July 1 2020. The bank said this was to stem speculative borrowing. In June 2021, the Monetary Policy Committee Statement maintained the Bank policy rate at 40 percent and the interest rate on the Medium-Term Accommodation Facility at 30 percent per annum, and further tightens monetary policy by reducing the reserve money growth target from 22.5 percent per quarter to 20 percent per quarter going forward.	In March 2020, the RBZ moved from a fixed to a managed float exchange rate regime. The RBZ also revised the FX allocation priority list to improve allocation efficiency in light of the prioritize COVID-19 pandemic. Faced with acute foreign currency shortages, in June 2020, the RBZ introduced a foreign currency auction system and reinstated the 30-day limit of liquidating surplus foreign exchange receipts from exports which was further revised to a 60-day limit for FX liquidation.

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	In 2020, the authorities' ZWL$18 billion Stimulus Package for COVID-19 aimed at: (i) providing liquidity support to agriculture, mining, tourism, SMEs, and the arts; (ii) expanding social safety nets and food grants; (iii) setting up a health sector support fund; and (iv) scaling up investments in the social and economic infrastructure in Cyclone Idai affected communities. They also supported the food security related programme which included wheat farming and maize procurement, and the Pfumvudza Programme which support vulnerable households with farming inputs. Zimbabwe is heavily indebted and access to regional and international finance is currently restricted. The authorities secured a US$10 million loan from the Arab Bank for International Development (BADEA) for the procurement of PPEs and laboratory equipment to support COVID-19 measures. Inflation, which remains high, has been trending down and was at 106.64 percent (y-o-y) in June 2021 (relative to 837 percent in August 2020).		

Appendix 1.3 : Impact of climate change on crops and agriculture

Angola	The agriculture sector is the fourth largest contributor to Angola's GDP (around 7-9%), is underdeveloped but employs 51% of the population[169] . Family farming produces 80% of cereals and subsistence farmers suffer poor conditions and inability to modernise their working methods. Projections of temperature increases will lead to crop losses, significant reduction in suitable area for beans and cassava[170], and drive increased hunger and malnutrition[171].
Botswana	Crop production, mainly sorghum, corn, and millet, is hindered by traditional farming methods, recurrent drought, erosion, and pest disease[172]. Increased likelihood of droughts and prolonged dry periods will increase soil erosion and exacerbate land degradation. The livestock sector is very vulnerable to climate change. Under the RCP 6.0 by 2070, the number of calves born will likely to be lower than the baseline. Subsequently, the supply of milk could fall short of the national demand[173]. In most of the region, a decline in yields is predicted but an average increase in cowpea yields is projected under both RCP4.5 and 6.0, increases in maize and sorghum yield are obtained for Gaborone and pearl millet in Maun region.
Eswatini	Around 70% of the country's rural population is dependent upon subsistence agriculture. [174]Annual precipitation is one of the most fundamental climatic conditions for rain-fed agriculture and livestock productivity. The decrease in precipitation will make certain crops or farm practices unprofitable. Small farmers owning about 77% of the total cattle population and the number of livestock has been declining in recent years due to droughts and overgrazing of rangelands[175].
Lesotho	Agriculture is a major source of employment in Lesotho, and is dominated by maize, representing 60% – 70% of the country's labour earnings. Subsistence dry-land farmers are more vulnerable to climate change than commercial farmers. Climate change will have mixed impacts, but generally decreasing yield. Projected changes in precipitation and increases in temperature from September to May for the northern part of Lesotho through mid-century is likely to have a positive impact on yields for maize, sorghum, and wheat but negative impact on growth of crops, such as beans and cucurbits[176].
Madagascar	Agriculture is dominated by small-scale, predominantly subsistence farming that is rain-fed and based on traditional technologies[177]. Rice in Madagascar is mainly grown in irrigated lowlands (66% of rice area). Maize production is projected to decrease over large parts of Madagascar due to reduced precipitation, even if conservation agriculture techniques are used. Rice and sugar cane yields are projected to drop due to water stress and an increase in parasites[178]. Livestock production is also affected as food intake decreases above 30 °C and due to reduced forage quality and quantity and lower capacity of rangelands.
Malawi	Agriculture accounts for roughly 90% of the country's export earnings and is highly vulnerable to changes in average annual rainfall patterns, floods, droughts, and strong winds. Industrial export crops are grown by smallholders[179]. Declining soil fertility and inappropriate and outdated agricultural technologies, with underdeveloped systems to use existing water sources are issues for the agricultural sector. Food reliance on maize when other types of cereals more adaptable to drought are available.
Mauritius	Agriculture occupied 42 % of the land area in 2005 and is dominated by sugar cane cultivation whose contribution to the GDP represented only 3.2 %. Projected reduced rainfall and an increase in evapotranspiration due to warming may lead to a decline in agricultural production by as much as 15-25% in the medium and longer term[180].
Mozambique	The country's agricultural production features small-scale subsistence farmers and 95% of food production is rain-fed. The onset of more subtle changes, such as groundwater salinization and higher soil temperatures will be likely to lower yields.
Namibia	Crop production is second to livestock rearing in importance due to low rainfall. Only 2% of the country's total surface area is arable and 46% is appropriate for perennial natural pasture. Agriculture exports (mainly livestock, meat and grapes) form a key part of the country's trade portfolio. Climate change will negatively affect cereal crop production, livestock production, and fisheries. Even heat-tolerant crops such as millet are likely to be negatively affected by climate change in drought-prone areas. Cereal crop yields are estimated to decline by up to 20% in the northeastern region and by 50% in the northcentral region under rainfed conditions.

Appendix 1.3 : Impact of climate change on crops and agriculture

São Tomé & Príncipe	Agriculture plays an important role in the production of food and products for export. The RCP4.5 scenario for the period from 2041 to 2070, shows reduction in maize in areas classified as high risk, possibly due to the increase in air temperature. In the RCP8.5 scenario, there is an increase in the area classified as very high risk due to the increase in thermal stress and susceptibility to rust.
South Africa	Agriculture is a critical sector for the South African economy, contributing significantly to food security and export revenues. Maize dominates the sector, followed by wheat and to a lesser extent sugar cane and sunflower seed. Livestock production is a significant part of the sector. Only 14 % of the country is considered arable, out of which, one-fifth of this land characterized as having high agricultural potential. Heat stress already poses challenges in livestock populations, leading to a reduction in milk production and reproduction. Warming is expected to alter growing seasons and reduced water availability will likely increase soil moisture deficits.
Zambia	Maize yields for Central, Luapula, Northern and Muchinga Provinces may increase only marginally in both the near and far future. Significant increases in millet production in Eastern Province in both the near and far future is projected whereas significant decreases are projected in Western and Southern Provinces for the same time periods. The rest of the country is likely to remain more or less normal in both time horizons.
Zimbabwe	80% of agricultural production is rainfed. Maize is an important agricultural product as it is the staple food and gaining even more importance. Even commercial farmers have shifted their focus from maize to high-value cash crops such as tobacco or shifted to horticulture. Major food producing regions have declined over the years[181] . Although sorghum and millet are drought-tolerant, they are not as popular as maize is with the population.

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