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State of the Environmental Challenges on Changing Climate in Southern Africa

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Abstract:

The world faces serious environmental issues like climate change, pollution, biodiversity loss, and landscape changes, which affect all countries. These challenges are particularly severe in Southern African Development Community (SADC) countries. This study highlights major environmental problems in the region, including climate change, land degradation, deforestation, pollution, lack of clean water and sanitation, and poor urban conditions, all of which threaten the Sustainable Development Goals (SDGs). Despite progress in environmental management, more action is needed. SADC governments, NGOs, the private sector, and other stakeholders must work together to address the root causes of these problems. Strengthening coordination and implementing key interventions across different sectors is crucial. Beyond environmental concerns, SADC faces geopolitical and economic challenges, including weak international trade, political instability, poverty, declining economic performance, and debt. The findings suggest that policymakers should develop and enforce policies that promote climate change adaptation from a broad, interdisciplinary, and cross-border perspective.

Keywords:

Environment, Environmental Challenges, Climate Change, Southern African Development Community (SADC), Sustainable Development Goals (SDG).

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Introduction

The changing climate has been at the forefront of environmental challenges for the past few decades (Belie, 2018; Li et al., 2022). The Intergovernmental Panel on Climate Change (IPCC) has played a vital role in bringing climate change issues to the attention of the public and policy makers (Paglia & Parker, 2021). It poses serious risks and an enormous threat to human development more especially in developing countries. As a result, the achievement of the Sustainable Development Goals (SDG's) global community efforts to decrease hunger and poverty are undermined (Sporchia et al., 2024). Climate change is an issue globally, with Africa identified as particularly vulnerable to its impact due to it having fewer resources to adapt (Filho et al., 2021) and Southern Africa as the most threatened region with low adaptive capacity (Ayanlade et al., 2022).

Southern African countries contribute relatively little towards global climate change due to the low levels of energy-related GHG emissions (Wang et al., 2024). The main source of GHG emission in Southern Africa is from burning fossil fuel (liquid fuels and especially coal in the thermal power stations of South Africa) and de-forestation due to the traditional use of biomass as a primary energy source (Obileke et al., 2019; Tetteh et al., 2024). The region is already under pressure from climate stresses and climate in the region is predicted to become more variable with more frequent and extreme weather events such as droughts and floods (Engelbrecht et al., 2024; Scholes & Engelbrecht, 2021). For example, despite the affected areas contributing little in GHG emissions, the recent extreme weather of El Nino that has caused a drought in Southern Africa that has devastated over 27 million people in recent months, leading to the worst hunger crisis the region has seen in decades.

Southern Africa is vulnerable to climate change and variability because the majority of the population makes its living from the land and agricultural production (Okolie et al., 2023; Omotoso et al., 2023). The reduction in annual rainfall in Southern Africa seen in the 20th century is a threat to crop production. The region experienced severe droughts in the early 1980s, at the beginning of the 1990s, in 2015 and in 2023/2024 (Banze et al., 2018). This was as a result of the magnitude of the inter-annual rainfall variability (Rouault et al., 2024, Synodinos et al., 2018). Climate change continues to threaten global health and security (Lewis, 2019; Toteja et al., 2023; Wade, 2016). The changing patterns of rainfall contribute to the spreading of vector-borne diseases such as malaria (Caminade et al., 2019). According to The World Health Organization 2017 the African continent continues to carry a disproportionately high share of the global malaria burden with 92% of all malaria cases and 93% of all malaria deaths in 2017.

Global warming has the potential to weaken the region's adaptive capacity and undermine development efforts in key sectors of the region's economy, reducing livelihood security and thereby increasing poverty and delaying or preventing the realization of the SDG's. Accordingly, this paper provides an overview of some of the significant environmental problems in the Southern African region.

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Methods and Data

The main data for this review came from an online collection of literature about environmental challenges related to climate change in Southern Africa. This included looking at reports, articles, research from databases, peer-reviewed journals, conference papers, and other reliable sources. The review used certain criteria to decide which studies to include or exclude (Page et al., 2021) (see Fig. 1). Key terms like “loss of biodiversity,” “deforestation,” “desertification,” “waste,” “population growth,” “urbanization,” “pollution,” and “poverty” were used in our search on Science Direct, which gave us 1,610 articles. We focused on articles from the last ten years (2014-2024), narrowing it down to 1,208 articles. We then reviewed 377 articles for eligibility, of which 317 were in English. From 122 articles published between 2009 and 2024, 72 had over 10 citations and were chosen for the review. We set a limit of 10 citations per article to focus on the most important research. The final selection for content analysis included 57 articles that were most relevant to our research goals.

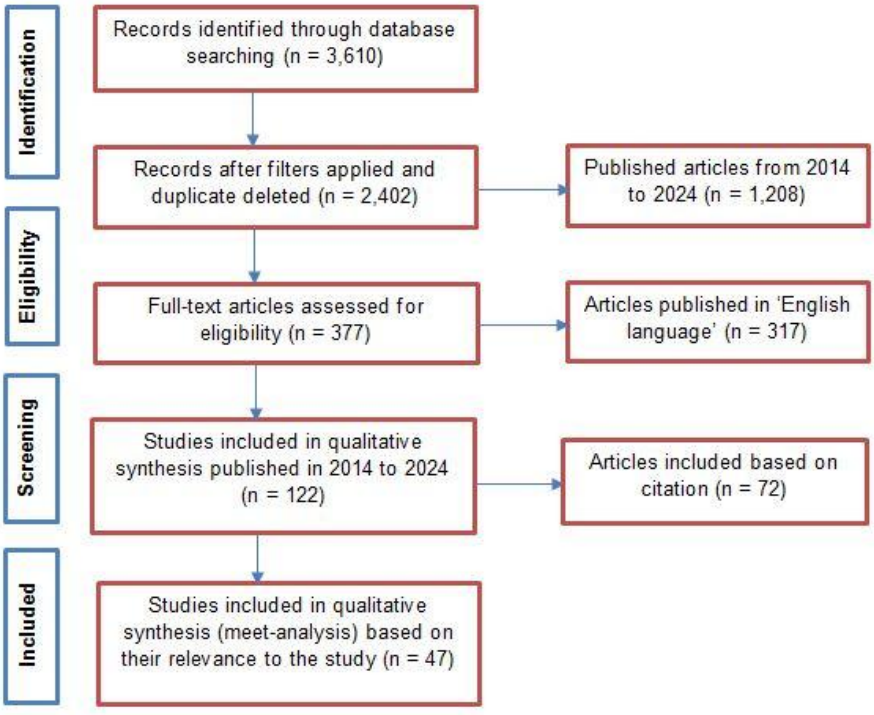

Figure 1: PRISMA flow diagram

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Results and Discussion

Biodiversity

Biodiversity is referred to as the variety and variability among living organisms and the ecological complexes in which they occur (Burch-Brown & Archer, 2017). The southern African region is known as the richest natural heritage of global significance to the world's climate and biodiversity. The Cape Floristic Region (CFR), one of the world's six floral kingdoms, is a biodiversity hotspot located in South Africa. The CFR is the most remarkable region in the world's five Mediterranean climate regions (Colville et al., 2020) that cover only 2% of the earth's land area (Rundel et al. 2018) with approximately 9000 species, 69% of which are endemic (Goldblatt & Manning, 2000). South Africa alone has the third highest level of biological diversity in the world, with 10% of the world's plant species and 7% of its reptile, bird and mammal species (Sell et al., 2024). Furthermore, it harbours around 15% of the world's marine species (Department of Forestry, Fisheries and the Environment, 2024). Endemism rates reach 56% for amphibians, 65% for plants and up to 70% for invertebrates (Department of Forestry Fisheries and the Environment, 2022). This high level of diversity is brought about by the broad range of climatic, geological, soil and landscape forms found in that part of the region (Esler et al., 2015).

However, many species are under threat from natural and human pressures and extinction rates in the region are high by global standards (Boonman et al., 2024; Gonçalves et al., 2024; Scheffers et al., 2019; Sintayehu, 2018). The issues that threaten biodiversity include invasive alien species (Dueñas et al., 2018), climate change (Bickton, 2016; Kapuka & Hlásny, 2021), nutrients loading and pollution (Lukhele & Msagati, 2024; Olisah et al., 2021), habitat change (Skowno et al., 2021), urbanisation and overexploitation (Kivyiro, 2023). For example, poaching for tusks has reduced the population of elephants (Campbell-Staton et al., 2021; Parker et al., 2021). Likewise the poaching of leopards for skins and black rhinos for horns has caused them to be nearly eliminated almost to extinction in some countries (Janssens & Trouwborst, 2018). Additional factors are government policies that encourage agriculture (cash crops for export), forestry and human settlement (including sedentarisation of nomads and villagisation) in previously natural habitats; and the appropriation or nationalization of land by the state.

Deforestation

Deforestation has recently become a major concern for developing countries (Ahmed & Olaitan, 2024). Wei et al (2023) estimates that Africa suffers a net loss of 3.4 million hectares of forests and woodlands per year (FAO, 2020; Wei et al., 2023). The average annual rate of deforestation of the region (0.6%) is still by far higher than the world average (0.15%) in 1990-2020 (FAO, 2020). Globally, the rate of net forest loss declined from 7.8 million ha per year in the decade 1990–2000 to 5.2 million ha per year in

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2000–2010 and 4.7 million ha per year in 2010-2020 (FAO, 2020). Deforestation is one of the major environmental problems in SADC (Davis-Reddy & Vincent, 2017). The most common vegetation landscape in Southern Africa is grass and scattered trees (Osborne, 2018). Excluding the Democratic Republic of Congo, rainforests are rare in Southern Africa because of the low rainfall (Tang, 2019). The Democratic Republic of Congo together with remote parts of Angola has two thirds of the forest region (Tyukavina et al., 2018). Mozambique, Tanzania, Zambia, Botswana, Lesotho, Malawi, Namibia, South Africa, Swaziland and Zimbabwe account for the remaining one third. Deforestation rates in Southern African countries are quite high (Heneine & Stephens, 2020). Between 2005 and 2015 an estimated 812 000 ha per annum were cleared, equivalent to about 1.1 percent of the total forest area (Blomley & Iddi, 2009).

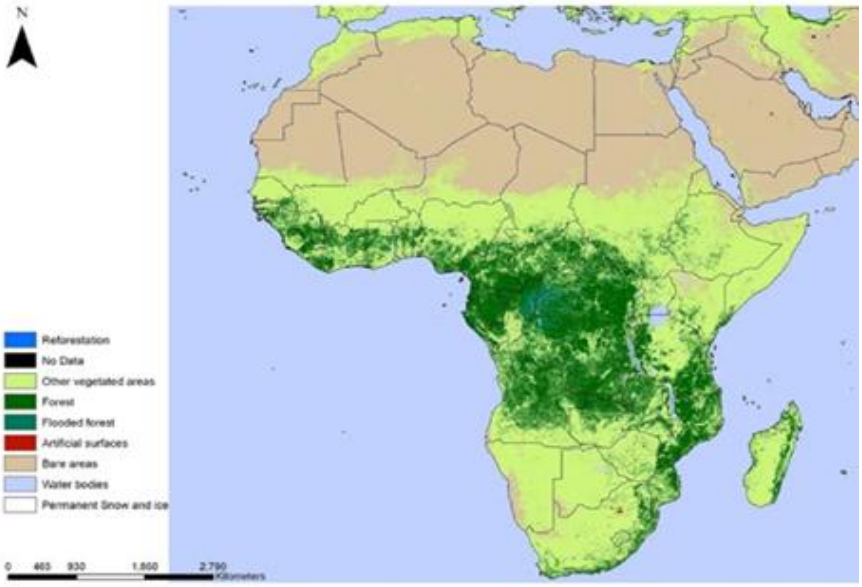

Figure 2: Forest cover in Sub-Saharan Africa (Source: World Agroforestry Centre 2019)

The main direct causes of deforestation are: clearing for agriculture, overgrazing, wildfires, charcoal-making, persistent reliance on wood fuel for energy, overexploitation of wood resources and lack of land-use planning (Blomley & Iddi, 2009). Reliance on wood fuel and charcoal for energy supplies has been identified as a key driver behind high national rates of deforestation and degradation and it presents a real challenge as almost all domestic energy consumption, both rural and urban, is derived from these sources (Miles & Kapos, 2008). In Mozambique and the Congo, forests are being overexploited to provide much needed foreign exchange. On the other hand, Mozambique, Tanzania and Zimbabwe are amongst countries that are clearing forest for planting tobacco and larger areas for fuels with which to cure the tobacco leaves (Jew, 2017; Muvengwi et al., 2020). Tanzanian forests are under threat because humans are harvesting wood for fuel, eating fewer wild plants, and massive changes in land use

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(Kayombo et al., 2020; Mahushi et al., 2021). Environmental damage from fuelwood harvesting can be significant if too many people depend on too few forested areas and the ecosystem services they deliver (Harvey & Guariguata, 2021; Netshipise & Semenya, 2022; Sola et al., 2017). Commercial gain is always the priority with the threat to ecosystems services only an afterthought. Unless there is a mind shift and change in attitude forest resources will continue to be plundered.

Desertification-Land Degradation

Land degradation is identified as the single most pressing global issue (Akça et al., 2022) and it has been a major global issue during the 20th century. Land degradation is defined as the reduction of production capacity of land in term of loss of soil fertility, soil biodiversity, and degradation of natural resources due to water and wind erosion of soil (Grinand et al., 2019). Fig 3 shows that in Southern Africa land degradation is mainly caused by water and wind erosion, sedimentation, destruction of vegetation and decrease of the natural resources (Issaka & Ashraf, 2017). In rural areas of Southern Africa, overgrazing followed by agricultural activities, deforestation and overexploitation of vegetative cover are the primary causes of land degradation (AbdelRahman, 2023). Furthermore, the increase in population has contributed to changes in land cover patterns, land fragmentation and livelihood insecurity (Lipper & Benton, 2020). The increasing demand for food, energy and other environmental services has contributed to the expansion of agriculture and to deforestation, often leading to environmental degradation (Nguyen et al., 2023).

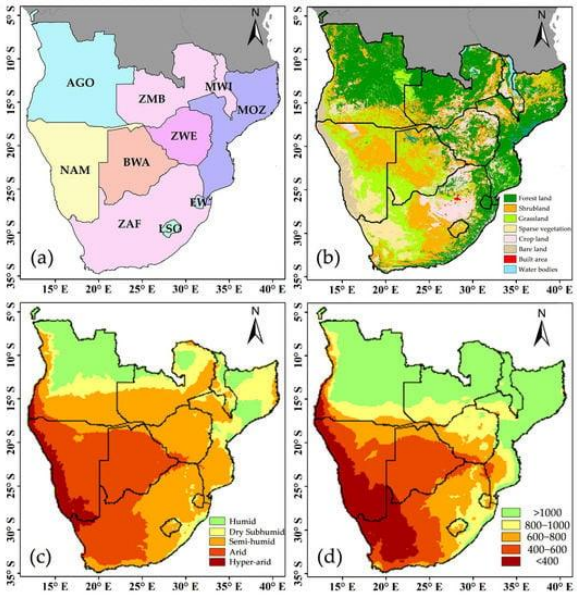

Figure 3: Desertification: land degradation under a changing climate (Source: Li, 2023)

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The high urban demand for food and biomass energy from rural areas has also contributed to rural deforestation and overall environmental degradation (Ndunguru, 2024; Temudo et al., 2020). Other factors leading to deforestation and forest degradation are: an increasing agrarian population, socio-economic dynamics, and increased demand for forestry resources with few alternatives or substitutes, and a weak agriculture support extension system (Reed & Stringer, 2016). In some areas crop production has decreased by 50% due to soil erosion and desertification (Chagutah, 2013). Desertification effects can be seen in loss of soil fertility, soil compaction, and soil crusting (Dregne, 1986). Desertification has an impact on about 45% of Africa's land area. In Southern African soil degradation leads to a decline in crop production that poses food insecurity in several areas (Masipa, 2017; Sithole et al., 2016) and is linked to hunger and poverty (Tully et al., 2015) which threatens attainment of the SDGs.

Waste and Littering

There is a growing understanding at global level of the negative impacts that waste can have on the local environment (air, water, and land), human health and safety (Abubakar et al., 2022; Raphela et al., 2024). Littering involves solid or liquid waste products (useless or unwanted) that have been illegally dumped at an in-appropriate site (Grobler et al., 2022). Waste can be anything: food, leaves, newspapers, bottles, construction debris, factory chemicals, candy wrappers, disposable diapers, old cars, or radioactive materials (Kibria et al., 2023). Waste is generally the local governments' or municipalities' responsibility. Several countries in Southern Africa are facing challenges regarding waste management by their local municipalities and this poses a risk to the environment and to the health of individuals (Kubanza, 2024). The increase in waste generation in Southern African countries far exceeds their ability and capability for its safe disposal (Tahulela, 2017). Many African cities experience serious issues on waste management (Amoah & Kosoe 2014; Bello et al., 2016). Most African countries lack the required resources to process the growing amount of solid waste, for example: lack of proper disposal technologies and methodologies, inadequate manpower and equipment, low management capacity and the high costs involved in the management. Fig 4. shows waste management in developing countries is typically characterized by uncontrolled dumping of waste, often associated with open burning, while Fig 5. shows developing countries typically have a large, active informal waste sector that recovers valuable resources from these dumpsites.

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Figure 4: Uncontrolled dumping of waste (Source: World Environment Day 2018)

Figure 5: Informal sorting of and picking of waste (Source: Godfrey, 2018)

This results in more than 90% of waste being dumped or burned on land-fills in the Southern African region and increases the threat of air pollution (Njewa, 2025). The burning of waste contributes to climate change and in 2016 the global emission generated from solid waste management was between 3 and 5% excluding transportation (Abdel-Shafy & Mansour, 2018; World Bank, 2018). In South Africa it is estimated that in 2017 54.2 million tonnes of general waste were generated compared to previous years (Mbazima et al., 2022; Verster & Bouwman, 2020). It is also estimated that 38.6% of general waste was recycled during this period. In areas where waste is not collected residents dump their garbage in the nearest vacant land, river, or burn it. The resulting foul smells and the proliferation of pests and insects that transmit diseases have serious health and environmental implications (Tahulela, 2017). For

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example, cholera in Zimbabwe has been linked to waste disposal (Marumure & Nyila, 2023; Mashe et al., 2023).

Where legislation is available, enforcement is lacking. However, SADC is taking steps to improve understanding of household, industrial, agricultural and e-wastes and the associated challenges they present. In order to ad-dress these challenges, the Southern African Development Community is committed to promoting sound environmental management through pollution control, waste management and environmental education. In addition to this concerted effort by government, what is really required is a mind-set shift to curb random littering and for the public to embrace and participate in recycling.

Population Growth

According to Simkins (2021), population growth in SADC is seen as rapid by global standards. Simkins (2021) notes that the population grew from 277 million in 2010 to 363 million in 2020, representing an average annual rate of 2.6% growth. In a region 6 of an estimated population of 363 million people, 6.4 million international migrants were identified mid-year 2020.

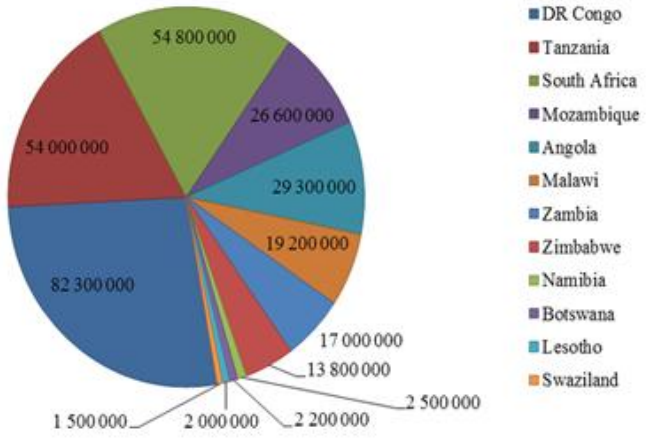

Figure 6: SADC population

The combined population of Botswana, Lesotho, Namibia, Swaziland and South Africa increased from 15.5 million in 1950 to 50.13 million in 2001 and may reach 77.2 million in 2020 and even 106.8 million by 2050 (Darkoh, 2009). Though there have been speculations that HIV and Aids will slow the population growth, it is increasing steadily. It is becoming increasingly clear that population growth and economic development are leading to rapid changes in our global ecosystems (Peterson, 2017). Population increases involve fundamental human biological needs such as water, food, clean air, clothing, shelter and relative climatic constancy which influence ecosystems (Sabino & Pulhin, 2021). In addition to

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providing life's basic (above-mentioned) needs, changes in their flow affect livelihoods, income, local migration and, on occasion, political conflict. Overpopulation is the major cause of environmental degradation (Bifulco, 2023; Cafaro et al., 2022). As a result of rapid population growth and poverty in Southern Africa poor rural com-munities are increasingly forced to degrade the environment.

Urbanization

Urbanization refers to the increasing number of people that live in urban areas (Kuddus et al., 2020). According to (United Nation Population Division) predictions on urban growth by 2050 64.1% and 85.9% of the developing and developed countries respectively will be urbanized. In Africa, due to urbanization, more than half of the population currently lives in urban areas (United Nations, Department of Economic and Social Affairs (UNDESA). United Nations Statistics Division. 2018 (UNDESA), 2018). The Southern African region is the most urbanized (Gambe et al., 2023). The end of apartheid in South Africa has resulted in a major increase in cross-border and intra-regional migration. The factors that lead to movement are: high rates of rural and urban poverty, high levels of unemployment and different levels of social service provision (Ngubane et al., 2023). These have contributed to making mobility an increasingly important livelihood strategy. South Africa remains the preferred destination for many migrants (Owusu-Sekyere et al., 2019).

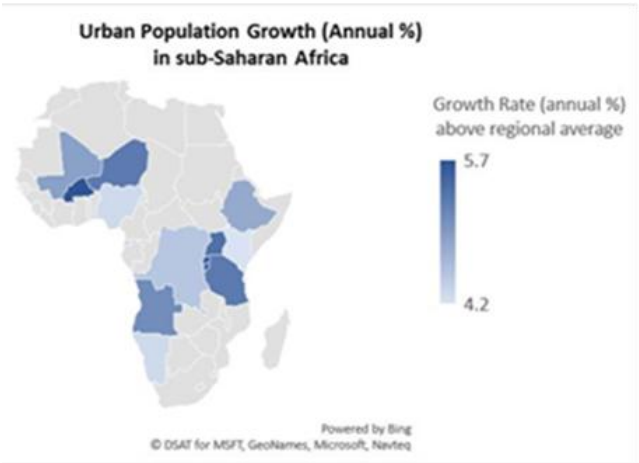

Figure 7: Sub-Saharan Africa, urban population growth rate (Source: World Bank, 2017)

These factors have created further problems as the mi-grants tend to settle in over-crowded, unsanitary and unhealthy conditions with waste almost impossible to manage and dispose. Fig 7 shows countries on the continent with urban growth rates and some are members of SADC. Namibia, Angola, D.R. Congo and Tanzania are the top four countries within SADC with high urban population growth annually between 4.2% and 5.7%. This rapid urban growth presents more challenges. For example most poor people in these urban cities live in squalor and along river banks in some of the most unsanitary housing

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conditions with no jobs. Because of the high urban growth local government often finds it difficult to provide the necessary services to ensure a healthy and good quality of life. For example, in Harare the municipality cannot provide clean water and this has led to the cholera disease.

Pollution

According to World Health Organisation (WHO) pollution is a major environmental risk to health across the globe (Rentschler & Leonova, 2023). The SADC region is seen as a low producer of air and water pollution. However, the key sources of pollution in the Southern Africa region includes industry (thermal coal powered stations, smelters, cement factories, chemical factories), forest savannah fires, biomass burning (use of firewood and char-coal), waste burning and transportation emissions (Brunekreef & Holgate, 2002). Unfortunately, there is a growing reliance in coal powered stations in South Africa which means air pollution is likely to remain high (Greenpeace 2023).

Although pollution is a growing issue, it also allows Southern African countries the opportunity to plan accordingly in terms of monitoring and evaluation and trying to minimize pollution on the environment and community. Pollution is connected to a number of human health and environmental impacts including respiratory diseases and heavy metals poisoning (Masindi & Muedi, 2018) that affects lakes by increasing levels of acidity or nutrients which, in turn, affect water quality and aquatic biodiversity (SADC). The health problems caused by pollution in Southern African countries are identified as the same health problems faced by both developed and developing countries (Fisher et al., 2021).

The Southern African region has different sources of pollution; in Tanzania it is mainly associated with petroleum refining, Kraft pulp and paper, phosphate fertilizer and cement manufacturing industries (Wrigh et al., 2017). While in Mauritius, pollution came from road traffic and a number of industries such as burning of sugar cane foliage and bagasse in factories leading to high emissions of ash, soot and volatile organic com-pounds (Amigun et al., 2011; Musango et al., 2011). In South Africa, sources of pollution include industrial combustion of fossil fuels (Perera, 2017), domestic burning of coal, wood and paraffin for cooking and heating, and exhaust fumes from motor vehicles (Wright et al., 2017). The conducted studies display sufficient evidence to suggest that pollution is a problem to environmental and human health. The changing climate has the potential to have varying and widespread effects on human health and on the ecosystem, and can influence air pollution (Arshad et al., 2024; Bolan et al., 2023). Climate change models and predictions indicate that Southern Africa will be severely affected by climate change in terms of extreme weather events (Ranson et al., 2016). Accordingly, the Southern African region is considered a priority region for creating and enabling an environment for adaptation (Engelbrecht et al., 2024) and mitigation. Unfortunately, there appears to be no mind-set shift and a business as usual approach remains. There are more coal power stations being built, more combustion

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cars on the road and a general lack of awareness as well insufficient data to illustrate and tackle the problem of air pollution (Perera, 2017).

The SADC region responded to pollution by forming key the Air Pollution Information Network for Africa (APINA) (Modise, 2017). Its role is to address issues related to air pollution in Africa and to coordinate follow ups to the 1998 Harare Resolution on Prevention and Control of Regional Air Pollution in Southern Africa and its likely Transboundary Effects. The Regional Policy Framework on Air Pollution developed by the United Nations Environment Programme was adopted in Lusaka, Zambia in March 2008 and recognizes the importance of the following:

Air pollution takes a high toll on the health, environment and economies of African countries; More than 50% of all trips are non-motorized and mainly on foot, combined with inadequate public transportation and poor urban planning African roads are the world's most dangerous; Increasing emissions of SO2, NO2, particulate matter and heavy metal emissions from the industry and power generation sectors; Ammonia emissions from the agricultural sec-tor have an impact on human health; Open burning contributes to environmental and health effects; and Indoor cooking with solid fuels leads to high exposure of particulate matter to women and children (SADC).

Poverty

Poverty is defined as "the inability to attain a minimal standard of living'' measured in terms of basic consumption needs or income required for satisfying them (Wolff, 2022). Poverty remains one of the biggest challenges in Africa (Durojaye & Mirugi-Mukundi, 2020; Zhang, 2024). The penetration of poverty is greatest in sub-Saharan Africa (Leal Filho et al., 2024; World Bank, 2016). SADC is known as one of the poorest regions in the world (Mosito & Setlojoane, 2018) despite being endowed with a variety of natural resources from oil, gas, and a variety of minerals. According to The International Council on Social Welfare (ICSW) approximately half of the total population is living on less than $1 per day. Hunger, malnutrition, gender inequality, exploitation, marginalization, high morbidity and HIV and AIDs are some of the complex challenges that contribute to poverty in the SADC region. Reducing poverty is a global concern and has become one of the most important objectives of policy makers in developing countries for donors and international financial institutions. Poverty eradication is at the top of the Southern African Development Community (SADC) agenda. Poverty is a major cause of environmental degradation as poor people often rely on the land and natural resources for survival (Musakwa & Wang 2018). Consequently, poverty is a major issue to be tackled if SDG 1 on poverty reduction and SDG 15 on protecting, restoring and promoting sustainable use of terrestrial ecosystems are to be achieved. Indoor cooking with solid fuels leads to high exposure of particulate matter to women and children (SADC).

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Conclusion

Southern African countries have joined hands and are working together towards addressing environmental issues facing the region on national, regional and international levels through climate related programmes and initiatives. For example:

- *Need for Stronger Institutional Coordination and Policy Enforcement*: National governments must improve coordination between agencies and stakeholders to guarantee that climate policies are not only enacted but also successfully implemented, particularly in the areas of urban and rural development.
- *Increased Investment in Research and Long-Term Climate Programmes*: It takes a large investment in scientific research, climate-resilient infrastructure, and long-term sustainable programs supported by steady political commitment and leadership to turn environmental concerns into action.
- *Urgent Requirement for Sustainable and Integrated Planning*: Climate projects run the risk of becoming short-lived or maladaptive if they are not properly planned for and funded. To prevent ineffectual or detrimental interventions, integrated approaches that take socioeconomic, environmental, and political variables into account are crucial.
- *Addressing Structural Global Inequities and Regional Barriers*: Southern Africa needs to push for more equitable international trade conditions to addressing debt loads and political instability. These systemic issues need to be cooperatively addressed on a global scale to promote climate resilience and sustainable regional development.

However, there is more that can be done in terms of climate laws and policy implementation. At the national level the different agencies and players, both within and outside government, need to strengthen coordination and implementation of key interventions in different sectors in both rural and urban areas. Environmental awareness and concern are becoming increasingly important factors among decision makers in the region as they seek to expand development of their economies. This concern needs to be translated into coordinated tangible and long term solutions that consist of research, programme development and implementation, with high levels of political commitment. Relevant policies and institutional frameworks have been adopted in the region, nevertheless the challenge is to use them effectively and efficiently to deliver sustainable solutions in the region. However, without adequate funding to implement and without integrated planning, the region runs the risk that some initiatives or infrastructure investments may be maladaptive. There is also an important need to address geo-political forces and issues that contribute to slow development of Africa regional and international. These issues have been addressed several times with little success at finding amicable solutions. Amongst the major matters are poor terms of international trade, political instability, poverty,

declining economic performance and international debt. However, the above-mentioned problems consist of historical and contemporary underlying factors that require to be addressed as urgent issues of global fairness.

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